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ECONOMIC GEOGRAPHY

APRIL

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LAND VALUES IN THE BLUE GRASS AND NASHVILLE BASINS
Raymond E. Murphy, *Geographer,* University of Wisconsin

CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

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AUSTRALIA

AUSTRALIA forms the antipodal frontier of white man's progress. A continent in area, an island in character and isolation, it constitutes a magnetic lure to imperial dreams and desires, to pristine adventure and achievement. It lies like a gem of colonial potentialities on England's brilliant crown of Pacific possessions, a gem still somewhat in the rough but of lustrous promise.

Australia bids fair to become the white man's continent its people wish it to be. None of the continents is so dominantly white, so deeply intent upon remaining so as is Australia, so well situated to keep the white blood pure. Dominantly agricultural and pastoral with few resources to make it industrial or commercial, it can retain its insularity of place and population, and leave its pioneer Anglo-Saxon peoples to perpetuate their blood untainted and uncolored, a nursery and reservoir of Nordic strength!

Aridity is Australia's widespread curse. Only a narrow coastal fringe of rain-blessed hills and watered plains borders the parched pasture lands and furnishes the fields and farms and orchard lands, so essential to the white man's granary and table. Relatively little of its continental expanse can ever be subdued and held in agricultural subjection, for the desert mallee and mulga scrub are incorrigibly rebellious, and have ever as irresistible allies the inadequate rainfall and subtropical temperature.

It is the desert that says nay to the ambitions of the Commonwealth, the dreams and desires of its settlers, the hopes of Britain that Australia shall homestead in the years to come hundreds of millions of her sons and daughters, a teeming people from coast to coast; "rather," say the desert and the sea "here shall we nourish and shelter between us, and save for the millenia to come, a fine, selected stock of sturdy, staunch British, pure in blood and undefiled.

ECONOMIC GEOGRAPHY

VOL. 6 APRIL, 1930 No. 2

AGRICULTURAL REGIONS OF AUSTRALIA

INSTALMENT I

Griffith Taylor

Professor of Geography, University of Chicago

AMONG the seven continents, Australia fills a humble place not only from her small size, but to an even greater extent from her general environment. From the point of view of agriculture, she is a long way down the list of the world's chief countries. Thus as regards area of cropped land the following is approximately the order of importance of the continents. (The data are largely from Whitbeck and Finch.)

THE GENERAL ENVIRONMENT

It is impossible to obtain figures for the whole continent for Asia, South America, and Africa. However, the relation between population and crops is fairly well known for Asia, and from it one can make a rough estimate of the total area of cropped lands in Africa and South America where similar primitive conditions are found.

Continent	*Population* (Millions)	*Estimate of Cropped Land* (Million Acres)
Asia	870	800
Europe	500	570
North America	144	360
Africa	124	113 *
South America	65	68 *
Australia	6	16

* Estimated without definite information; none available.

In the following table the recorded and estimated areas are summarized, by millions of acres:

Asia		Canada	20
China	400	Cuba	1
India	300	Total ....About	360
Siberia	34		
Japan	18	**Africa**	
Java	8	Algeria	10 *
Formosa	2	Egypt	7
Total ....Over	762	Total	113 *

Europe		**South America**	
Russia	250	Argentine	47
Germany	65	Chile	3
France	60	Uruguay	2
Spain	40	Total	68*
Hungary	35		
Italy	30	**Australia**	
Austria	25	New South Wales	4½
Roumania	15	Victoria	4½
Remainder	50	South Australia	3
Total ....About	570	West Australia	2
		Queensland	1
North America		Total	16
United States	300		
Mexico	30		

* Estimated without definite information; none available.

Thus Australia agriculturally is at present only as important as a small country like Roumania. It is, however, because her cropped lands can be considerably extended and can everywhere be used more intensively that she merits considerable attention.

Among the continents Australia stands out in a number of ways. In addition to the small size, we must note the low level of most of the continent. Only about 5 per cent has an altitude exceeding 2,000 feet. The almost unbroken character of the coastline contrasts markedly with the "peninsular" character of most of the other continents. It has most affinities with North Africa both as regards topography and latitude, and like North Africa a large proportion of it is arid. The following table shows how the rainfall is distributed.

Annual Rainfall	*Under 20 inches*	*20–40 inches*	*Over 40 inches*
Australia .....Largely hot	66%	22%	12%
Asia .....Largely cool	67	18	15
Africa .....Largely hot	54	18	28
North America ....Largely cool	52	30	18
Europe .....Largely cool	47	49	4
South America ....Largely cool	16	8	76

This table explains why our agriculture covers so small an area, for

unfortunately Australia is essentially the *hot* arid continent, just as Asia is the *cool* arid continent. In the south of Australia, however, much of our agriculture is carried on with rainfalls as low as 12 inches, so that this factor must be examined in detail; for total rainfall is only one of the many physical controls affecting agriculture (see Fig. 1).

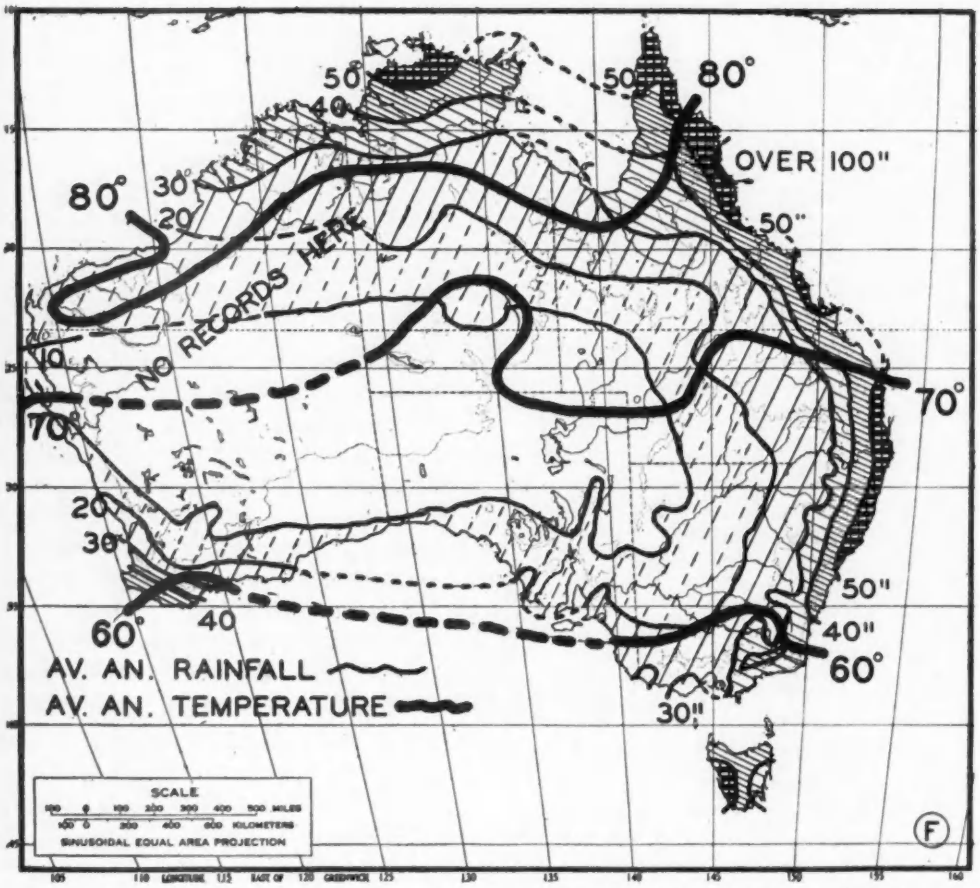

FIGURE 1.—A composite map of the average annual rainfall and the average annual temperature of Australia.

RAINFALL RÉGIME

The continent may be divided into five fairly definite rainfall regions depending on the amount and season of the rain. A line extending from North-West Cape to Sydney separates the northern half with *summer rains* from the southern half with *winter rains*. This is the primary division. But, along much of the east coast there is a series of low-pressure systems which move southwards especially in autumn and give a good deal of rain. Furthermore, the steady onshore east winds (Trade Winds) of the northeast give a fairly uniform rain throughout the year along the northern half of the east coast.

In the interior of the continent neither the winter or summer rains are abundant, and here life has adapted itself to arid conditions

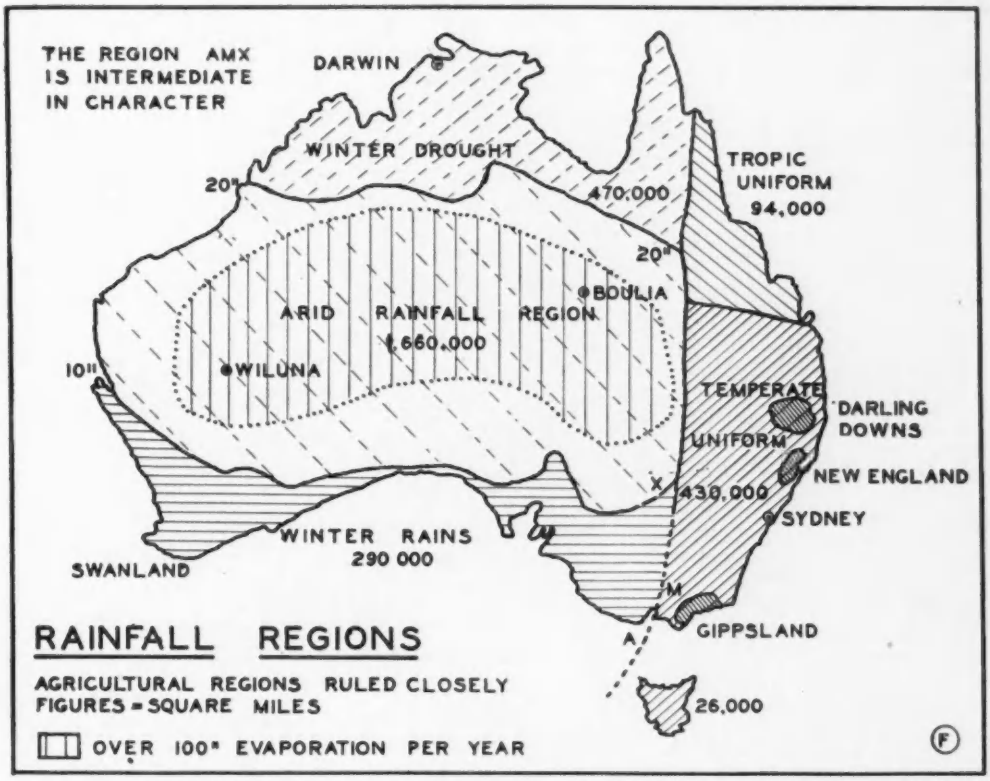

FIGURE 2.—The rainfall regions of Australia as related to its agricultural possibilities. Much of the continent exhibits marked seasonality of rainfall.

whether the infrequent rains belong to the summer or winter season.

From a study of native vegetation and economic possibilities the writer has adopted the 20-inch isohyet (with 100 inches evaporation) as the northern boundary of the arid region, while the 10-inch isohyet (with 60 inches of evaporation) is the corresponding southern boundary. In the east the uniform-rain boundary passes through places where 8 months

Temperate Group	*Area in 1,000 Square Miles*	*District*	*Chief Products*
A. Uniform	456	Southeast Queensland East New South Wales East Victoria Tasmania	Timber, dairies, orchards, farming, sheep, wheat, maize (sugar in north).
B. Winter rains	290	Swanland (West Australia) Coast of South Australia	Timber, dairies, orchards, farming, sheep, vines, wheat.
C. Arid	1,660	Interior and Central West Coast of Australia	Cattle in north and more rugged and drier regions; sheep in south and east. (One-third of area is quite unoccupied.)
Tropical Group			
D. Eastern coast (uniform)	94	Central coastland of Queensland	Timber, dairies, sugar, small plantations of tropical products, cattle.
E. North (winter drought)	470	North Coast of Australia	Cattle.

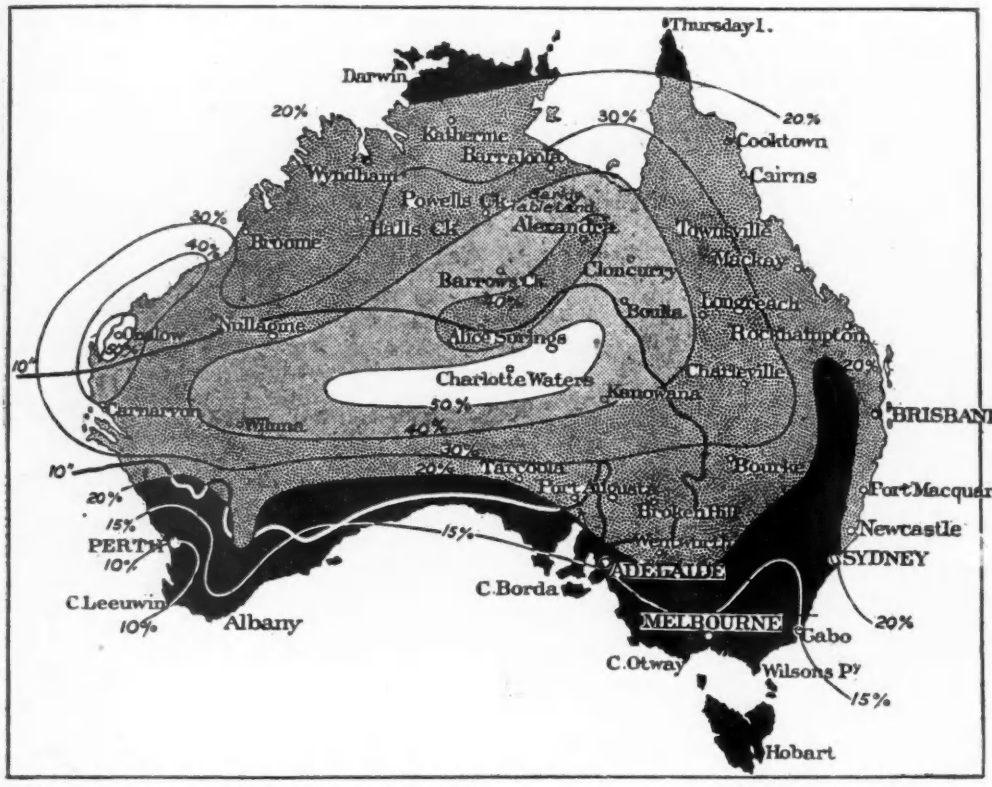

FIGURE 3.—Rain reliability for Australia. Percentages show average deviation from the mean. Most reliable—black; least reliable—white.

in the year have over one inch of rain. In the west, owing largely to the offshore winds, the arid region extends to the coast (see Fig. 2).

It is perhaps unnecessary to state that the preceding table (and map) (Fig. 1) refers primarily to agriculture. Other limits would be more useful if one were concerned directly with the pastoral industry—or with delimiting the desert areas.

We may now dwell on the character of the rainfall in these five regions before we consider the distribution of natural vegetation (see Fig. 2). Ignoring the east coast for a time, we see that the greater part of the continent exhibits a very marked seasonal rainfall. As the sun swings from the northern tropic (June) to the southern tropic (December) the belt of cyclonic storms swings in unison, but about a month later. Speaking generally, July is the wettest month along the south coast, for then the Antarctic belt of cyclones (*Lows*) is farthest north (in accord with the sun's swing). The two projecting areas of the south, Swanland (a short name for southwest Western Australia) and the coasts of South Australia receive good winter rains amounting to almost their whole annual precipitation. The heaviest rains occur close to the coast in Swanland and amount to 48 inches a year. In South Australia the heaviest are in the extreme southwest corner and only reach 33 inches (except for the top of the range near Adelaide which receives 47 inches). In West Victoria 78 inches is recorded near Cape

Otway. As Figure 1 shows, the rains rapidly fall off and the 10-inch isohyet runs fairly near the coast. The effect of the Antarctic *Lows* dies away inland and is hardly felt in the arid region north of the line joining North-West Cape to Sydney.

Turning now to the north coast of Australia we find a parallel state of affairs. Here, as the sun swings south, it may be pictured as dragging southwards the belt of Tropical *Lows* (or cyclones). They operate over North Australia during the months of December, January, and February, and give heavy rains during those months. But, there is practically no rain of note in the other nine months —and the characteristic feature of this large region is the nine months' drought. As a consequence the natural vegetation differs very little from that of the huge arid interior. It is almost wholly xerophytic except along the actual river banks and has no resemblance to the true jungles which occur along the east coast. Darwin is the wettest station with 60 inches, and 200 miles away the rainfall is 40 inches and soon drops to 20 inches as the map shows (see Fig. 1).

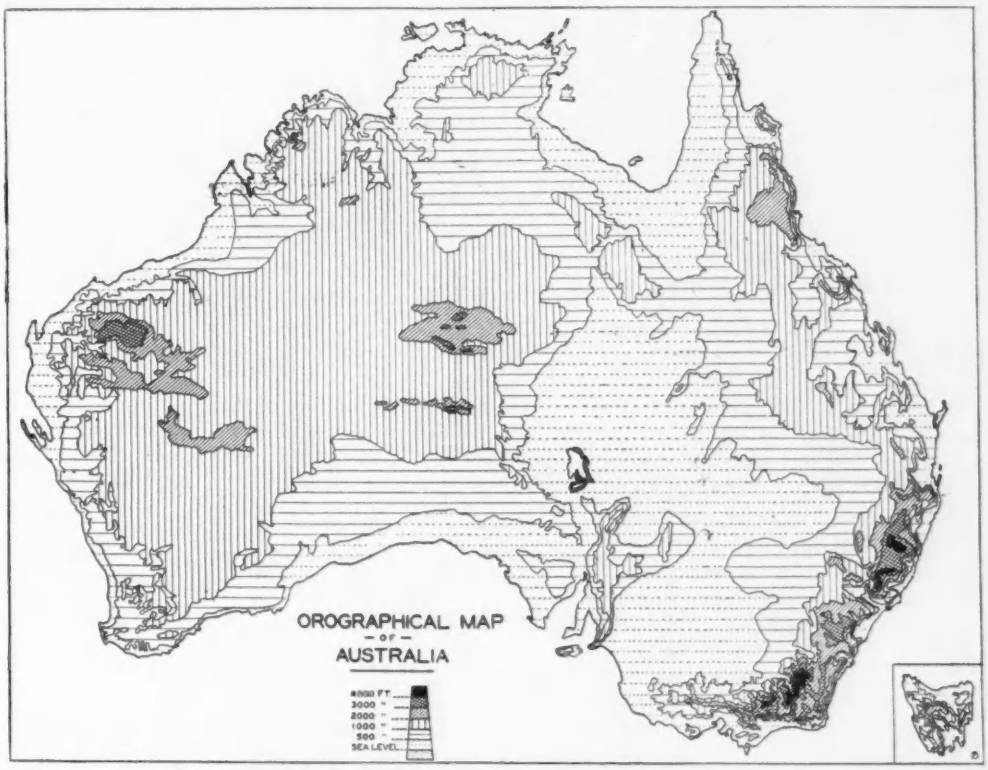

FIGURE 4.—Though most of the agricultural phenomena and distributions of Australia are controlled more or less directly by rainfall, the elevation, relief, and drainage of the continent locally cause most important and direct modifications of the normal climatic effects.

As regards the arid province as defined on the map, the characteristic feature of the country is the enormous evaporation. Along the central belt (from west to east) the annual evaporation is about 10 feet, while the rainfall is less than 10 *inches*. Boulia in West Queensland

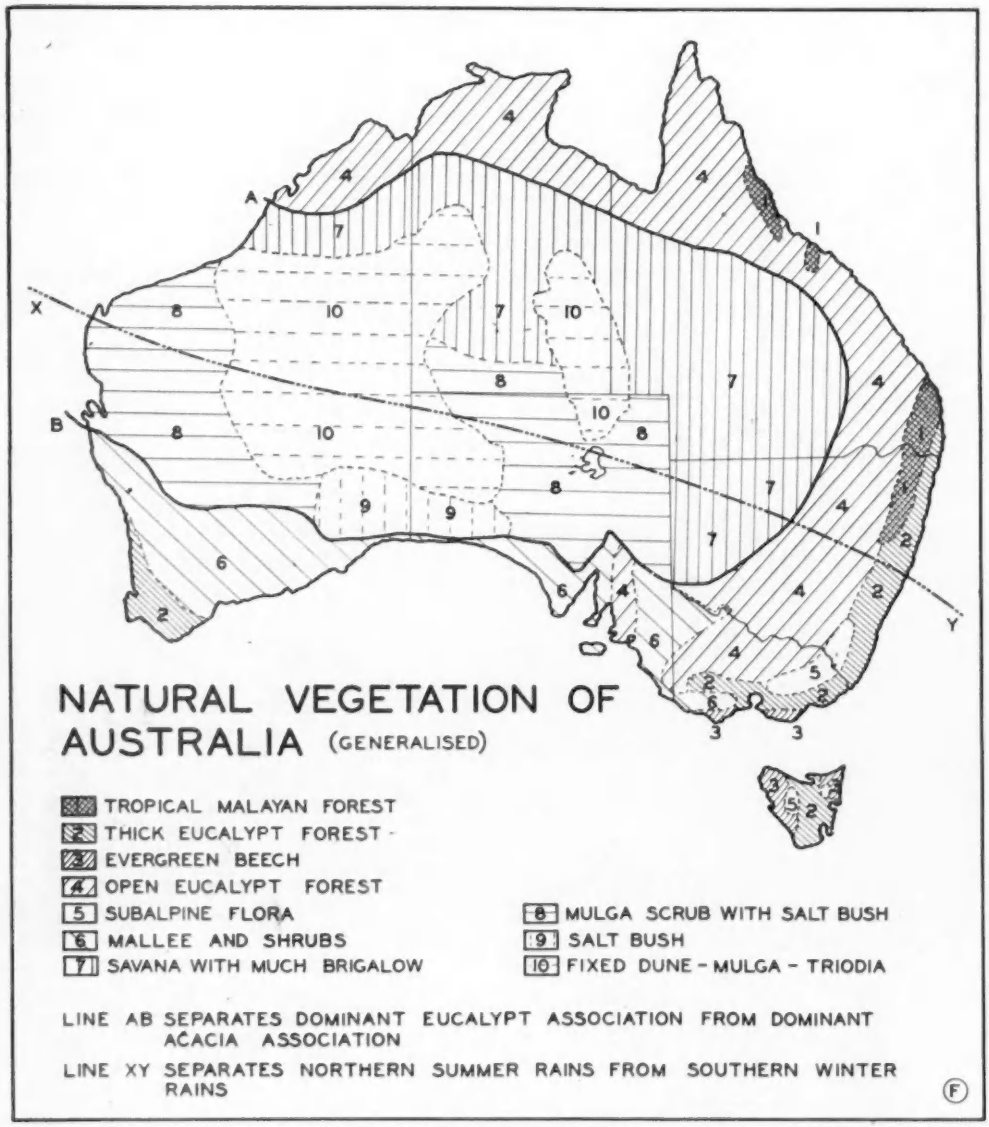

FIGURE 5.—A generalized delimitation of the natural vegetation regions of Australia as based upon the author's observations and Diels' map of 1906.

has an evaporation of 124 inches, and Wiluna in central West Australia has an evaporation of 153 inches. Thus, the region with over 100 inches evaporation a year nearly fills the area labelled "Arid Rainfall-Region." In addition to this the arid region has markedly *unreliable* rains, which deviate a great deal from the average. In nearly all the arid region the average variability is over 30 per cent.[1] This fluctuation is of course a tremendous handicap to stock owners, and makes agriculture an impossibility on any large scale (see Fig. 3).

We may now consider the two regions of fairly uniform rain. Obvi-

[1] Thus, a place with an average rainfall per year of 20 inches and a variability of 30 per cent would be likely to have 14 inches one year and 27 inches the next.

ously from what has been said there is a preponderance of summer rain to the north of Sydney, and of winter rain to the south of that city. But, all this eastern belt has over one inch of rain in 8 months of the year, while most of the temperate portion has over one inch of rain for 12 months of the year. Only a negligible amount (except in Tasmania and Gippsland, Victoria), however, has such a climate that the rainfall exceeds the evaporation. It is almost impossible to show it on a map of this scale, for it is a mere fringe along the coast.

In Tasmania the west coast lies in the path of the steady westerlies. Hence the western half of the island —which is mountainous—is so wet and bleak that it has no population except at the mines of the northwest (Fig. 1). The total rain exceeds 100 inches a year near Mount Lyell. In the highlands of Southeast Australia somewhat similar conditions are observed. The rainfall is over 60 inches and settlement is very sparse in the plateau areas.

In the northern portion of the Temperate Uniform area near Lismore the rainfall depends on proximity to the sea, rather than on elevation. A fringe along the coast some 10 or 20 miles wide has about 60 inches a year. On the New England Plateau (4,000 feet) the rains are lighter, only about 35 inches. But the temperatures are warm, and here is a good deal of farming and stock raising. Somewhat similar conditions with lower rainfalls are obtained in Southeast Queensland—and here the "downs" or upland country about 2,000 feet high is often good agricultural land (see Fig. 2).

FIGURE 6.—Mulga (*Acacia aneura*), the commonest tree in arid Australia. Photo at Kingoonya—rainfall 8 inches—by the author.

NATURAL VEGETATION

There are unfortunately no vegetation maps in Australia, not even of the settled portions. Hence, any map must be only an approximation to the truth. Yet, nothing gives a better clue to the agricultural possibilities of a new country than the map of the natural vegetation. For years the writer has been urging the preparation of such a map (combined with an approximate soil map), but

little has been accomplished to date. The writer has travelled through almost the whole of the continent, and the accompanying generalized map (Fig. 5) is based on his own experience and on Diels' approximate map of 1906.[2]

The salient division is that given by the heavy line *AB* which separates the dominant eucalypt flora from the dominant acacia flora. It is by no means a hard and fast line, but within this boundary the majority of the small trees are mulga, brigalow, or other of the many hundred species of acacia, while outside it in the wetter portions, the dominant trees consist of gums, ironbarks, boxes, stringy barks, and others of the three or four hundred species of eucalypt.

The next most important division is the line *XY* which approximately separates the northern (summer) rains from the southern (winter) rains. This does not greatly affect the dominant *tree* types, save that

FIGURE 7.—A lone Myall, one of the acacias growing in arid South Australia. Photo taken at Kingoonya by the author.

mulga (*A. aneura*) is the commonest acacia in the south, and Brigalow (*A. harpophylla*) is the commonest in the north. But, it seems to be the dominant control in the distribution of the natural forage growth. Thus, the Mitchell grass (*Astrebla*) association dominates in central Queensland, while the salt-bush (*Atriplex*) association dominates in the southern region. The salt-bush transgresses the seasonal rain line (*XY*) to a greater extent than does the grassland flora, but it does not reach far north of the MacDonnell Ranges.

[2] Diel: *Pflanzenwelt von West Australien*. Leipzig, 1906.

FIGURE 7a.—Bangalow palms (Archontophenix) characteristic of the tropical scrub now being cleared off to yield sugar-cane land in northeastern New South Wales, along the Clarence River. (Courtesy of New South Wales Govt.)

The largest remaining area consists of the huge regions of fixed dunes which cover about half a million square miles in the driest part of the continent. These dunes extend east and west for the most part. They are about 30 to 50 feet high, and 3 or 4 are crossed in a mile. They are "fixed" by a sparse growth of gums, mulgas, and above all by the so-called "Spinifex" (*Triodia irritans*), which is a sparse tussock grass growing in clumps up to ten feet across and several feet high. Thick belts of mulga occur in places, and ground-

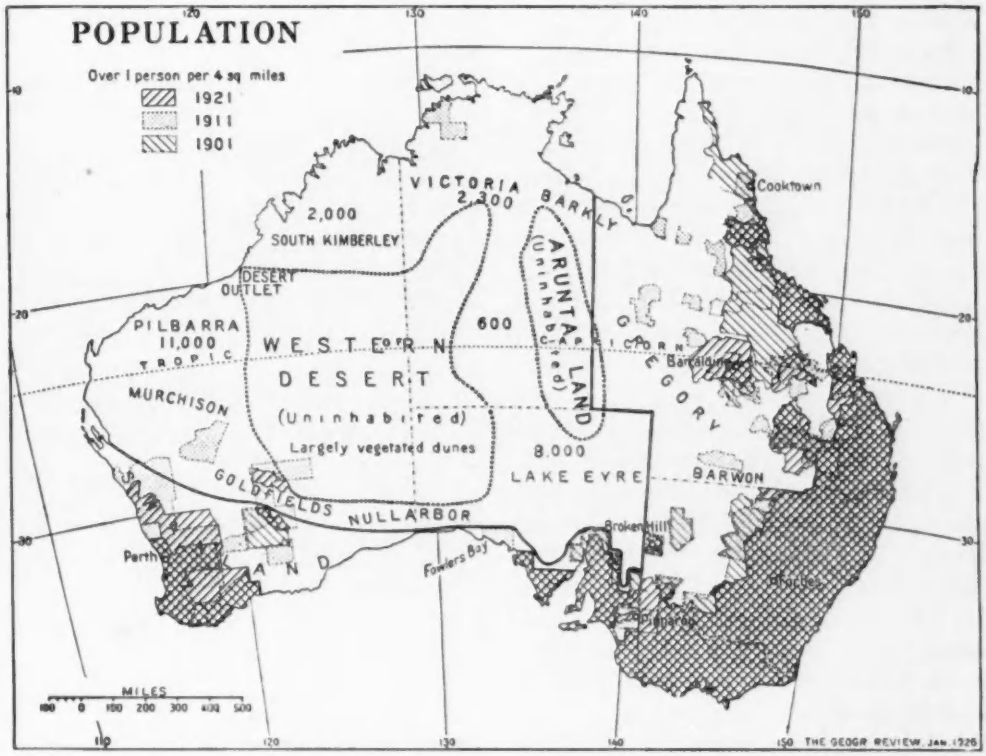

FIGURE 8.—The distribution of population in Australia at the last three censuses. The dotted lines inclose areas without white population (Western Desert and Arunta Desert). The area north and west of the solid line enclosing 54 per cent of the total contains little more than one-third of 1 per cent of the population. The districts on the "frontiers of settlement" are named, and the approximate population is given in figures. Scale of map 1: 44,000,000. (Courtesy of the *Geographical Review*, 1926.)

water can often be found at about 50 feet. There is no white man or head of stock in the two areas labelled "Fixed Dunes" on the map. There are considerable areas of hamada (stony ranges) and serir (pebble-waste) in this vast region but the fixed dunes dominate throughout.

POPULATION [3]

The population of Australia, which numbered 5,435,732 in 1921, is spread very unevenly over the 2,974,581 square miles of surface. An area almost as large as the United States has a total population considerably less than that of New York City. The white settlement of Australia started at Sydney in 1788, and it is a matter of considerable geographical interest to see how it has spread through the continent in the course of 137 years. Unfortunately our census districts have varied greatly during the last few decades, so that it is almost impossible to obtain accurate population-variation charts. However, there are official maps showing the chief grades of population density for each decade, and one can learn much from a consideration of the three last censuses.

Let us take the grade of one person per four square miles (see Fig. 8).

[3] In the discussion of population, the writer makes use of some paragraphs in his paper on "Frontiers of Settlement in Australia," published in the *American Geographical Review*, New York, Jan., 1926.

Comparing its boundary for 1911 with that for 1901, we find that in Queensland it runs much nearer the coast but that half a dozen "outliers" mark settlement in the interior. In New South Wales and South Australia the line is the same as in 1901 save for slight increase in the wheat belt in South Australia. In Western Australia a considerable expansion has taken place into the Murchison and Menzos goldfields.

The 1921 census almost everywhere shows no advance on the position of 1901. In Queensland the Barcaldine district has advanced, but elsewhere there would seem to be retreat. In New South Wales a slight retreat to the coast is apparent. In South Australia there is little change. In Western Australia there is an advance in the district northeast of Perth.

There has therefore been little addition to the population of the sparsely-settled regions ("sparselands" one may call them) in the past 20 years, in spite of a growth of one and a half millions in the total population of Australia. Official figures show the following distribution in 1921:

Six capital cities	2,338,079 = 43	per cent
Other towns	1,037,468 = 19.5	per cent
Rural population	2,030,422 = 37.5	per cent

One finds, however, that of this rural population some 94 per cent dwells in the reasonably settled areas near the towns and only about 6 per cent of the rural population dwells in the "sparselands."

The population map (Fig. 8) defines fairly accurately the limits of agriculture which correspond to the boundary of the "one person per square mile" area, except where there are large mines as at Kalgoorlie (in southern Western Australia), at Broken Hill (in western New South Wales), or in the rich sheep district of central Queensland.

Indeed, in most of the south of Australia the inner (dry) margin of the wheat belt is the limit of close settlement and thereafter the density of population drops to a very low figure indeed.

There is an impression in many circles in Australia that the *dry* interior is the chief *sheep* region of the Commonwealth. If one means *sheep per settler*, then this may be true, for little but sheep interests the population in these parts. But, if one means *sheep per square mile*, then the great sheep belt lies in the *wetter* areas or farmlands of Australia, and indeed the optimum belt for sheep is probably in wetter country than the optimum for wheat.

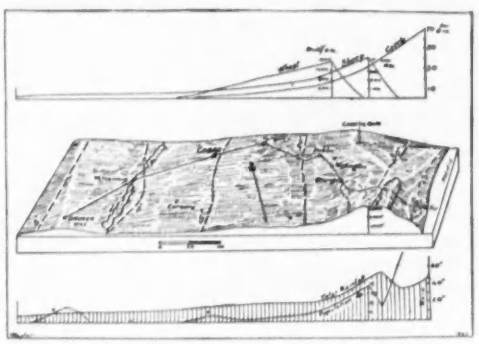

FIGURE 9.—The relation of climate to agriculture—particularly wheat, cattle, and sheep—is nowhere better illustrated than in Australia. Climatic controls along the Sydney-Broken Hill Route. The upper graphs show approximately the maximum densities per square mile for the counties in the various rain belts traversed. The block diagram shows the topography and the isohyets (annual). The lower graph shows the population density per county and the total rainfall.

Thus comparing the "densest belts" for cattle, sheep, and wheat in New South Wales, we find the following distribution. Cattle are most abundant on the coast, where the heavy rainfall ensures good permanent pasture for dairy cattle. The

FIGURE 10.—Clearing the mallee at Berri in eastern South Australia, near the Murray River, by burning the brush, pulling the stumps, and removing the timber. (Courtesy of South Australian Govt. Photo Dept.)

cattle graph in the following figure (Fig. 9) is somewhat generalized (and better illustrates a traverse somewhat north of the route from Sydney to Broken Hill), but shows that the cattle in the region with less than 20 inches of rainfall a year form only an unimportant proportion of the whole.

The maximum belt for sheep is near Armidale (north of Cassilis) and receives about 33 inches of rain per year. Rainfall above that amount tends from the top of the coastal divide to Nyngan. Many sheep are grazed in the drier regions (in the west of the State), but their density falls off rapidly to the west as the accompanying graph shows clearly.

As regards the wheat belt, on the whole it lies in somewhat drier country than the chief sheep belt. It extends from Orange southwards to Central Victoria though much grows on the margins of this optimum belt. There is very little wheat on the coast, which is too wet.

Finally, a few words may be said about the resulting distribution of population. The author has charted the densities of the counties passed through in the lowest graph. For Cumberland (*i.e.* around Sydney) the density was 430 per square mile at the last census (1911) available for that area.

The population falls off notably in the adjoining counties of Cook and Roxburgh. Here the barren sandstone soils and the deeply dissected topography of the Blue Plateau have counteracted the satisfactory rain-

FIGURE 11.—Tens of thousands of sacks of wheat awaiting shipment from Port Pirie, South Australia. (Courtesy of South Australian Govt. Photo Dept.)

tends to produce foot-rot, while if it be too light, pasture is not reliable. On the map, the chief sheep belt ex-

fall. The populous counties around Orange are next traversed, with richer soils and more kindly topog-

FIGURE 12.—Growing peanuts at the state experimental farm, near Warren, Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

raphy, though with somewhat lower rainfall. Thereafter, there is a steady falling off to negligible densities of population, except for the two mining townships of Cobar and Broken Hill. (Cobar had only 700 citizens in 1928.) Were it not for these two famous mineral centres the population of New South Wales would be almost negligible to the west of the 15-inch rainfall line, except in the Murray Valley.

AGRICULTURAL PRODUCTION [4]

The first settlers arrived in Sydney in 1788 under Captain Phillip and attempted to carry on British farming in an environment more closely resembling that of Carolina. The soil near Sydney is in general very poor, resulting from the weathering of Triassic sandstones (or somewhat inland, from shales). However, at Rosehill (10 miles from Sydney) 200 bushels of wheat and 60 of barley were harvested in December, 1789. About 40 miles to the west are extensive deposits of lake and flood silt along the Hawkesbury River, and here large crops of maize and lucerne are now grown, but the whole region is now known to be too wet for wheat. In 1813 the road over the deeply dissected Blue Plateau (4,000 feet) was discovered, and thereafter the drier western slopes were found to be excellently adapted to the growth of wheat.[5]

In 1850 about 198,000 acres were cultivated in New South Wales, 52,000 in Victoria, and 169,000 in Tasmania. The gold discoveries of 1851 withdrew the agricultural labor for a time, but soon led to a greatly increased demand for crops, so that by 1858 the land under crop in Australia totalled over one million acres.

The maximum area was cultivated in 1915–1916 as a result of a special war effort and reached 18½ million acres. In 1923–1924 it was 16½ million acres. Two noteworthy features stand out in the above table. Less than 1 per cent of the whole continent is cultivated—and yet, owing

FIGURE 13.—The grape harvest in the vineyards of Stanthorpe, Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

[4] The chief authority for this section is the Commonwealth Year Book (edited by C. H. Wickens).

[5] See block diagram, p. 663, *American Geographical Review*, 1925.

AREA UNDER CROP

(Thousand Acres)

Season Ending June 30	*New South Wales*	*Victoria*	*Queensland*	*South Australia*	*Western Australia*	*Tasmania*	*Total*
1880–1881	629	1,549	114	2,087	58	141	4,578
1900–1901	2,446	3,114	457	2,370	201	224	8,812
1920–1921	4,465	4,489	779	3,231	1,805	297	15,070
Percentage under crop, 1923–1924	2.4	8.3	0.2	1.5	0.37	1.7	0.87
Area per 1,000 people	2,177	2,881	1,075	6,789	6,566	1,274	2,875

to the small population, nearly three acres are cultivated for each unit of population.

Since the greater portion of the hay grown in Australia consists of wheaten or oaten hay, we see that the chief agriculture (80 per cent) is confined to wheat and oats.

	Acres
Wheat	9,540,000
Wheat hay	1,470,000
Oats	1,077,000
Oat hay	1,663,000
	13,750,000

Tropical crops consist almost wholly of sugar, while warm temperate crops are represented by maize. But these two together only amount to 3½ per cent of the total. Considering the States in some detail we find that in New South Wales wheat (1), hay (2), green forage (1), and maize (1) are the four leading crops.

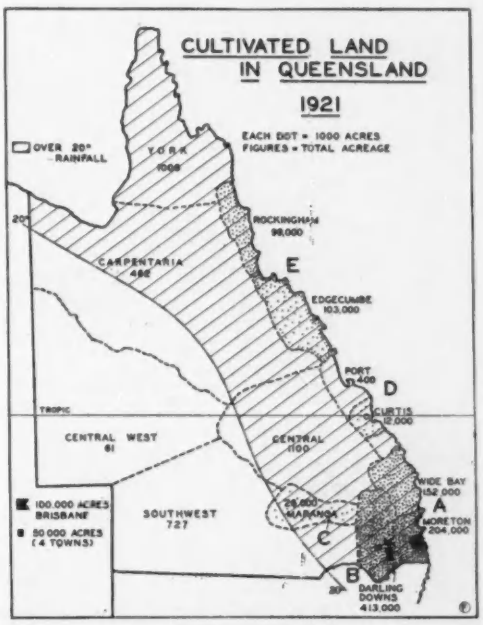

FIGURE 14.—The distribution of cultivated land in Queensland reflects the rainfall dominantly, the progress of settlement subordinately. The chief regions are distinguished on this map.

RELATIVE IMPORTANCE OF CROPS

(Thousands of Acres)

1923–1924	*New South Wales*	*Victoria*	*Queensland*	*South Australia*	*Western Australia*	*Tasmania*	*Australia*	*Per Cent*
Wheat	2,945	2,454	51	2,418	1,656	14	9,540	57.7
Hay	1,022	1,277	47	631	329	97	3,406	20.6
Oats	86	520	...	176	242	51	1,077	6.5
Green forage	430	107	307	55	52	10	961	5.8
Maize	167	29	120	...	...	..	316	1.9
Barley	4	56	...	184	8	4	256	1.6
Orchards	72	86	30	33	19	34	274	1.7
Sugar cane	17	...	220	...	...	..	237	1.4
Potatoes	22	59	6	5	5	37	134	0.8
Vineyards	14	42	1	49	5	..	111	0.7
Others	...	...	...	...	...	..	...	1.3

In Victoria wheat (2), hay (1), oats (1), and green forage are the chief crops. In Queensland green forage (2), sugar (1), and maize (2) are the leading crops. In South Australia wheat (3), hay, barley (1) and oats rank first. In Western Australia wheat, hay, and oats (2) are noteworthy. (Figures represent order of importance among States.) In Tasmania hay, oats, and potatoes are the main crops.

DETAILED STATISTICAL INVESTIGATIONS

Since the agricultural regions of Australia are not yet adequately exploited, it is impossible to treat the subject so systematically as has been done in Europe or North America. Wheat is the sole crop which is so widely grown that it may be plotted as a definite "Wheat belt." Oats and barley are scattered more or less in districts near the capital towns. The potato crop is even less definitely distributed. Sugar is still scattered in plantations along the northeast coast.

FIGURE 15.—A pineapple plantation, suggesting potential possibilities if adequate markets can be developed, at Woombye, near Gympie, southeast Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

For these reasons it has seemed preferable to study each State separately at first, and to give details of special crops or of special circumstances affecting crops in separate discussions later. Thus, the States will be considered in a statistical fashion, beginning with Queensland—the sole tropical State of any importance—and finishing with the vast State of Western Australia of which only about one-tenth at present has any prospects of agriculture.

AGRICULTURE IN QUEENSLAND

From the point of view of value the writer has taken the year 1921 as fairly representative, when the crops stood in the following order:

	Approximate Value, 1921	*Approximate Acres, 1921*
Sugar cane	£6,000,000	200,000
Wheat	1,000,000	175,000
Green forage	750,000	150,000
Maize	700,000	140,000
Lucerne	500,000	70,000
Bananas	400,000	10,000
Pineapples	170,000	4,000
Tomatoes	150,000	2,500
Oaten hay	130,000	13,000
Potatoes	120,000	10,000
Oranges	118,000	3,000
Wheaten hay	105,000	14,000
Remainder	357,000	13,000
Total	£10,500,000	804,000[6]

Thus, the crops listed represent 97 per cent of the state yield, and 98 per cent of the areas cultivated. (A new crop—cotton—was worth £287,000 in the year 1923.)

Let us now consider how these crops are distributed in the huge State of Queensland, which covers 420,000,000 acres.

DISTRICTS AND AREAS CULTIVATED

Agricultural Districts	*Towns*	*Areas Cultivated*
A. Moreton	Brisbane	204,000
Wide Bay	Maryborough	152,000
B. Darling Downs	Toowoomba	413,000
C. Maranoa	Roma	26,000
D. Port Curtis	Bundaberg, Rockhampton	12,000
E. Edgecumbe	Mackay	103,000
Rockingham	Townsville	99,000
Total for agricultural districts		1,009,000

[6] About 200,000 acres of fallow land can be added to this area making the total for the state just over one million acres.

FIGURE 16.—Harvesting wheat in the Gooburra valley among the Darling Downs of Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

Non-Agricultural Districts	*Towns*	*Areas Cultivated*
F. York Peninsula	Cooktown	1,000
Carpentaria	Cloncurry	462
Central West	Winton	61
Central	Emerald	1,100
Southwest	Charleville	727
Total for non-agricultural districts		3,350

If we now refer to the map where these areas and densities are plotted, it is readily seen that agriculture is only in its initial stages in Queensland. More than half of Queensland has over 20 inches of rainfall per annum, and probably a good deal of this huge area (especially in the east where the rain is more uniform) is suited for millet, ground nuts, and cotton. At present only the rich coastlands with more than 30 inches are utilized. There are, thus, five agricultural regions in Queensland (see Fig. 14).

A. *The Brisbane Region*, which extends north to Wide Bay and is continued in much the same country south to Grafton in the next State. Here grows market produce, sugar, maize, lucerne, and tropical fruits like bananas and pineapples.

B. *The Darling Downs*, where nearly all the wheat of the State is grown, and most of the lucerne. Here dairying, maize, cotton, and vines are also relatively important.

C. *Maranoa*. This region is much drier, and wheat is the only important crop. There is also a little maize, cotton, and vines.

D. *Central Queensland Coast*. Some sugar, maize, and tropical fruits are found here. This is also the chief cotton region in Australia.

E. *North Queensland Coast*. This is the chief sugar region. Dairying is increasing all along these coastal regions.

F. *Pastoral Regions* fill the rest of the State. However, millet and similar crops will in the future be grown in the wetter portions of the present pastoral area. In 1921 there were only 3,350 acres cultivated in all this western country. With few exceptions these insignificant patches are devoted to small vegetable and fruit gardens of purely local importance. Perhaps the only noteworthy exception is the growth of a little cotton and hay near Emerald.

AGRICULTURE IN NEW SOUTH WALES

The amount of cultivated land in this state is about 4¾ million acres. This is, however, distributed in a very irregular fashion through New South Wales. A table giving the areas in the 14 major land divisions will make this clear.

From the following table and the map (Fig. 17) it is obvious that the southern central portion of the State is

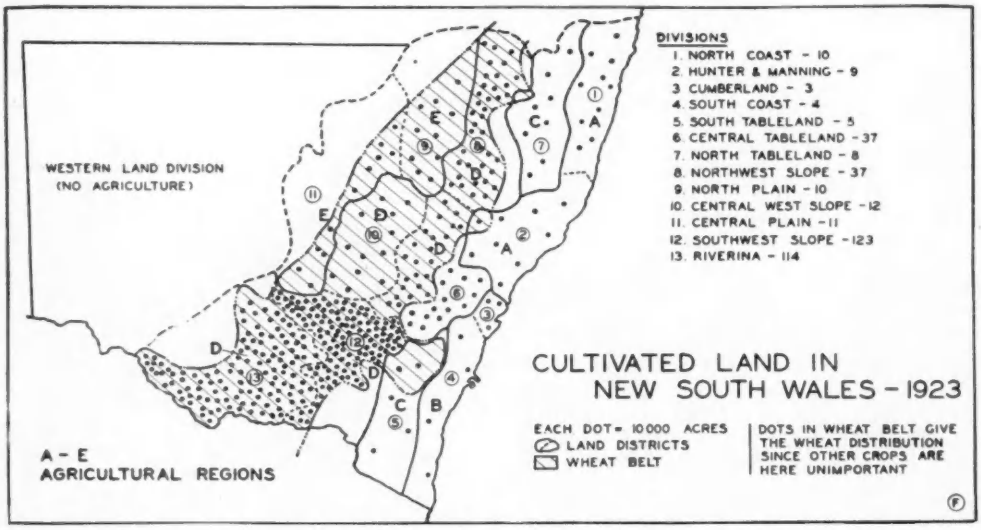
DIVISIONS
1. NORTH COAST - 10
2. HUNTER & MANNING - 9
3. CUMBERLAND - 3
4. SOUTH COAST - 4
5. SOUTH TABLELAND - 5
6. CENTRAL TABLELAND - 37
7. NORTH TABLELAND - 8
8. NORTHWEST SLOPE - 37
9. NORTH PLAIN - 10
10. CENTRAL WEST SLOPE - 12
11. CENTRAL PLAIN - 11
12. SOUTHWEST SLOPE - 123
13. RIVERINA - 114
WESTERN LAND DIVISION
(NO AGRICULTURE)
A - E
AGRICULTURAL REGIONS
CULTIVATED LAND IN
NEW SOUTH WALES - 1923
EACH DOT = 10000 ACRES
LAND DISTRICTS
WHEAT BELT
DOTS IN WHEAT BELT GIVE
THE WHEAT DISTRIBUTION
SINCE OTHER CROPS ARE
HERE UNIMPORTANT

FIGURE 17.—The distribution of cultivated land in New South Wales is closely dependent upon rainfall and topography. The chief regions are clearly presented.

by far the most important agriculturally. This includes the Riverina and Southwest Slopes of the State. The remainder of the Western Slopes rank next. The coast is not important except in the extreme north, and just around the Metropolis and Newcastle. There is practically no agriculture in the northwestern half of the State. The western boundary of wheat culture is shown on the map, and this is practically the limit of agriculture.

We may, therefore, classify the State in the following five regions (see letters on Fig. 17):

A. *The Coast north of Newcastle*, where all the sugar, bananas, pineapples, nearly all the maize and much of the oats and lucerne grow.

B. *The Central and Southern Coast*, where fruit and some maize and oats are grown. Both A and B are largely devoted to dairying.

CULTIVATED LAND, 1923

Agricultural Region	*Division*	*Acres*	*Chief Crops* (Figures in thousands of acres)
A.	North Coast	101,000	Maize (53), Oats (11), Sugar (14), Bananas (4).
	Hunter and Manning	91,000	Maize (27), Oats (10), Lucerne (25).
B.	Cumberland	31,000	Fruit, etc. (12), Maize (4), Oats (4).
	South Coast	47,000	Maize (17), Oats (13).
C.	North Tableland	77,000	Oats (26), Maize (23), Wheat (12), Potatoes (9).
	South Tableland	48,000	Wheat (13), Oats (17), Lucerne (12).
D.	Central Tableland	370,000	Wheat (245), Oats (57), Lucerne (26), Maize (8), Potatoes (9).
	Northwest Slope	370,000	Wheat (327), Maize (22), Lucerne (13).
	Central West Slope	946,000	Wheat (926), Oats (10), Lucerne (8).
	Southwest Slope	1,230,000	Wheat (1,100), Oats (88), Maize (10), Fruit (7).
	Riverina	1,147,000	Wheat (1,033), Oats (80), Fruit (10).
E.	North Central Plain	100,000	Wheat (98).
	Central Plain	124,000	Wheat (122).
	East of Darling	5,000	No agriculture of note.
	West of Darling	1,000	
	Total	4,718,000	

C. *The Northern and Southern Tablelands* are not important agricultural regions but oats and maize are a little more widely cultivated than wheat and potatoes.

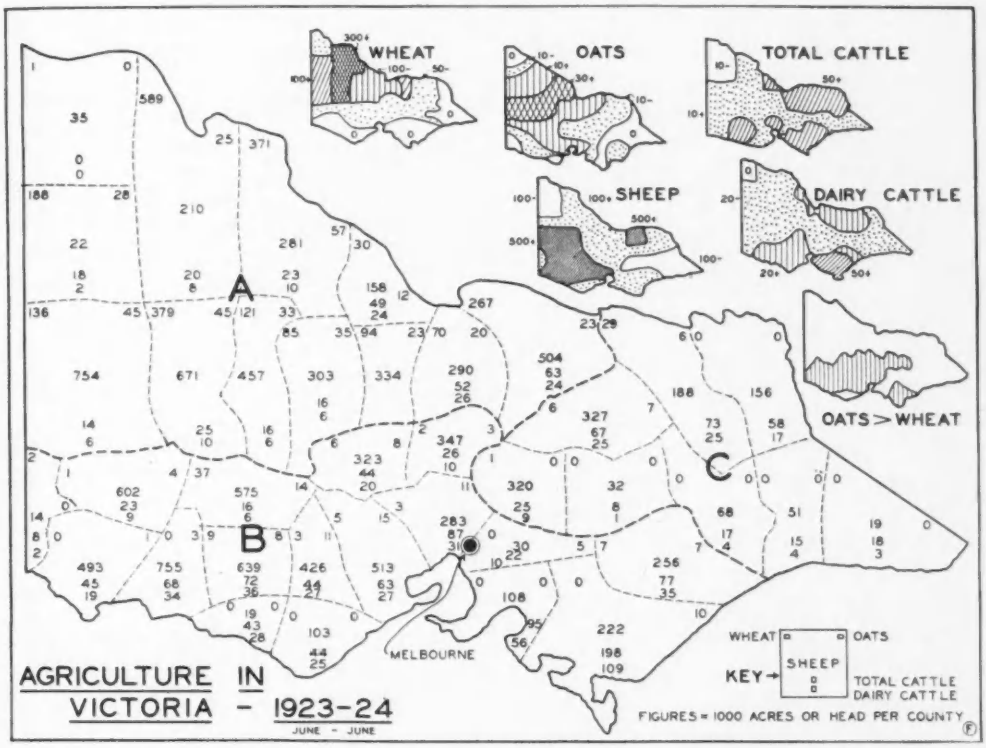

FIGURE 18.—A comprehensive graphic presentation of the status of agriculture in Victoria. The upper left hand figures refer to wheat, the upper right to oats, and the columns of three refer to sheep, total cattle, and dairy cattle from top to bottom.

D. *The Central Tableland and Western Slopes and Riverina* where wheat is by far the chief crop, but oats and lucerne are noteworthy.

E. *The Central Plains.* Only the eastern fringe of this region has any agriculture and here no other crop but wheat is important.

The following table gives the value of the principal crops in 1923:

Hay (wheat and oaten)	£8,884,000
Wheat	6,689,000
Maize	890,000
Green food	792,000
Fruit (except oranges)	732,000
Oranges, etc.	628,000
Market gardens	621,000
Sugar cane	348,000
Potatoes	319,000
Grapes, etc.	319,000
Oats	234,000
Tobacco	204,000

AGRICULTURAL REGIONS IN VICTORIA

This is almost the smallest state, occupying the southeast corner of the mainland. It is wholly in the temperate regions and resembles Portugal somewhat in its environment. The eastern portion consists largely of rugged plateau and the northwest of sandy heathlands, but the remainder is one of the chief agricultural areas in the Commonwealth.

The total area of the State is 56 million acres, of which 7 million are cultivated. An interesting table in the Victorian Year Book compares the agriculture of Great Britain and Victoria. These countries are almost the same size and not very different in environment.

	Victoria (Million)	*Great Britain* (Million)
Area (acres)	56	56
Wheat (bushels)	47	52
Oats (bushels)	9½	123
Barley (bushels)	1½	51
Potatoes (tons)	0.1	3½
Turnips, etc. (tons)	0.	26
Hay (tons)	1½	9
Horses (number)	½	7
Cattle	1½	7
Sheep	12½	22
Pigs	0.3	3½

Only in wheat and sheep is Victoria nearly as well developed. Britain is greatly in advance in oats, barley, and winter fodder like turnips. Winter feeding is, however, growing in importance in connection with dairying in Victoria.

The value of the principal crops in 1924–1925 was as follows:

	Millions
Wheat	£11.9
Hay	3.6
Oats	0.9
Potatoes	0.7
Barley	0.3

Wheat for grain represents about 54 per cent of all crops. About 90 per cent of the hay is oaten hay, which in Victoria is much more important than oats used as grain. We can thus divide the state into two main agricultural districts (Fig. 18): (A) the north and the northwest, where wheat is very much more important than oats, and (B) the south and center where oaten hay and oats together are much more important than wheat. The northeastern district, not so important, is characterized by almost equal importance of hay and wheat, with oats quite subordinate.

In region B, however, sheep and dairying are more important than pure agriculture. There is, of course, a great development of market gardens and orchards in the vicinity of Melbourne, with its 800,000 inhabitants. A little wheat is grown in the curiously dry rain-shadow areas right on the coast near Sale and Geelong. Maize and sugar beet are produced in Gippsland in small amounts.

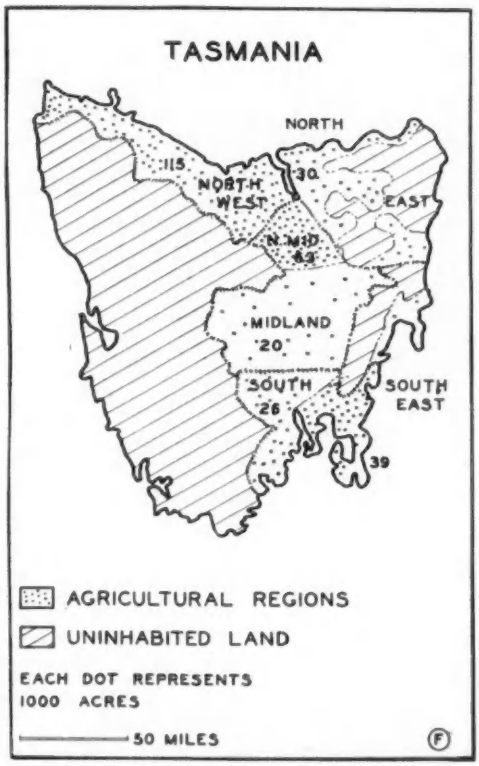

FIGURE 19.—A graphic summary of the agricultural land of Tasmania. Three major regions are portrayed—the North Coast, the Central Division, and the South Coast.

GENERALIZED TABLE SHOWING CROPS GROWN IN DISTRICTS IN VICTORIA

District	*Total Area* (Million Acres)	*Agricultural* (1,000 Acres)	*Pasture* (Million Acres)	*Unoccupied* (Million Acres)	*Chief Crops* (Per Cent)
A. Wimmera	7.5	1,750	4.4	1.4	Wheat 70, Hay 19, Oats 10.
Mallee	11	2,384	3.5	5.2	Wheat 73, Hay 13, Oats 11.
Northern	6	1,550	3.4	1.1	Wheat 64, Hay 19, Oats 10.
B. Central	4	441	2.4	1.2	Hay 51, Gardens, etc., 24.
North-Central	3	145	2.2	.7	Hay 55, Oats 14, Wheat 13.
Western	8.5	367	6.2	2.0	Hay 52, Oats 21, Wheat 17.
Gippsland[1]	9	168	4.5	4.3	Hay, Barley, Maize.
C. Northeastern	7	172	3.6	3.3	Hay 37, Wheat 31, Oats 13.

[1] The three southeastern counties of Victoria are usually linked with Gippsland in the statistics. In Fig. 18, however, they are added to the rugged northeastern district.

AGRICULTURAL REGIONS IN TASMANIA

Only about 2 per cent of the cultivated land in the Commonwealth is found in Tasmania. Yet, the island State is of special interest, for here

the driest portion is that most cultivated, and it is the *wet bleak* character of the west together with its rough topography which repels agriculture.

In Figure 19 it is seen that the rugged country of the western half, and of portions of the east, still belong to the State. The agricultural portions are all in alienated land. The approximate boundaries of the land divisions (in the alienated land) are indicated.

The value of the crops in 1922–1923 was approximately as follows:

Potatoes	£880,000
Apples	776,000
Hay	652,000
Oats	314,016
Hops	226,000
Peas	157,000
Small fruits	144,000
Wheat	142,000

Hence, vegetables and fruit are more important in Tasmania than are grain crops. Oats is more than twice as important as wheat, while hops and peas are also more important.

We may divide the State into three not very different agricultural regions:

A. The North Coast, which is characterized by the potato crop, but grows large areas of oats, hay, peas, and apples.
B. The Central Division, which is chiefly oats with some wheat.
C. The South Coast, where fruit (largely apples and berries) is dominant, but a good deal of hay and grain is grown.

FIGURE 20.—The concentration of cultivated land in the coastal counties of South Australia is clearly indicated by this map. The main divisions are indicated and named.

perhaps West Australia, shows such a sharp line of division between the closer settlement country and that used only for pastoral purposes. Indeed, the State is generally divided into two parts, the southern smaller moiety of 54 million acres which is divided up into 48 "counties," and a large moiety forming the remainder of the State ("outside the counties") which consist of 189 million acres. All the agricultural lands are in the counties (see Fig. 20).

TASMANIAN CROPS IN 1922–1923

District	*Area* (In millions of acres)	*Cultivated Acres*	*Chief Crops* (Figures in thousands of acres)
A. Northwest	3.2	115,000	Hay 39, Potatoes 27, Oats 25, Peas 11.
Northeast	2.7	31,000	Hay 12, Fruit 7, Oats 4, Potatoes 3.
B. North Middle	1.0	63,000	Oats 17, Wheat 10, Hay 21, Peas 7.
Midland	3.1	20,000	Oats 6, Hay 5, Wheat 2.
C. Southeast	1.3	40,000	Hay 19, Fruit 6, Wheat 6, Oats 4.
South	2.3	26,000	Fruit 17, Hay 3.
West	3.0	None	None

AGRICULTURAL REGIONS IN SOUTH AUSTRALIA

The amount of land under crops in this State (1923) was about 3½ million acres. No other State, save

We may, therefore, divide the agricultural lands (counties) of South Australia into five regions:

A. By far the most important is A, which surrounds the Gulf of St. Vincent. It includes

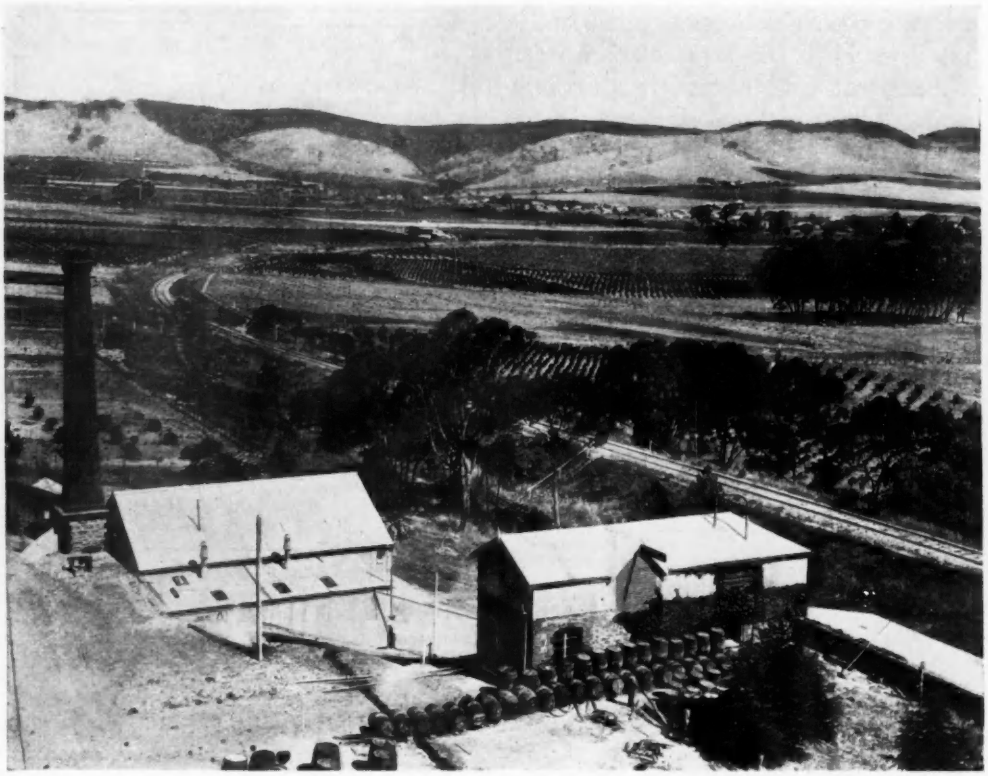

FIGURE 21.—A lovely landscape from the vineyard section about Tanunda, in hills north of Adelaide, South Australia. (Courtesy of South Australian Govt., Intelligence and Tourist Bureau.)

the Central and Lower North divisions. In this region nearly all the wheat, barley, and vines are grown, with much of the oats.

B. The Southeast Region grows much oats and some barley especially in the far south. Wheat is relatively less important.

C. The region along the Murray River where irrigation is practised is noteworthy. Here are important vineyards, while barley and wheat are grown to a large extent near the mouth of the river.

D. The Western Region is relatively important for oats and barley, but wheat is by far the chief crop.

E. The Upper North, where a small amount of wheat is grown.

The total area under crops was 3½ million acres, of which nearly 3 million were wheat and wheaten hay. The following table shows the value of the chief crops produced in South Australia in 1922–1923.

CULTIVATED LANDS IN SOUTH AUSTRALIA

Agricultural Region	*Division*	*Area in Acres*	*Cultivated Acres*	*Chief Crops* (Figures in thousands of acres)
A.	Central	6,500,000	962,000	Wheat (497), Hay (220), Barley (140), Vines (27).
	Lower North	5,000,000	928,000	Wheat (215), Hay (138).
B.	Southeastern	6,000,000	136,000	Wheat (48), Barley (24), Hay (35).
C.	Murray	9,000,000	673,000	Wheat (483), Hay (87), Oats (65), Vines (14).
D.	Near Western	6,500,000	253,000	Wheat (481), Hay (50).
	Far Western	11,500,000	350,000	Oats (46).
E.	Upper North	9,000,000	272,000	Wheat (226), Hay (40).

Wheat	£7,076,000
Wheaten hay	1,741,000
Vineyards	1,260,000
Oaten hay	797,000
Barley	681,000
Oats	287,000
Market garden	176,000
Potatoes	166,000
Oranges	164,000

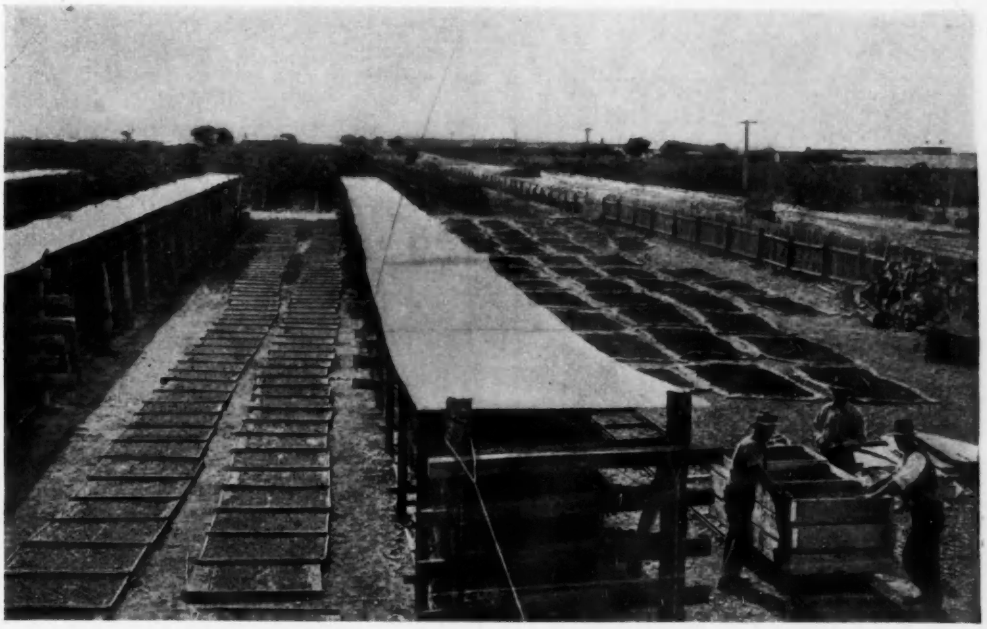

FIGURE 22.—Drying fruit in the sun at Renmark, at the extreme eastern end of South Australia near the Murray River. (Courtesy of South Australian Govt., Intelligence and Tourist Bureau.)

Lucerne	105,000
Dried fruits	104,000
Apples	102,000

AGRICULTURAL REGIONS IN WESTERN AUSTRALIA

This huge state contains almost one million square miles or one-third of the area of the whole Commonwealth. As far as agriculture and close settlement are concerned, only the southwest division is of importance—for here only is there a rainfall over 10 inches, with a temperate climate. This area (conveniently known as Swanland) is about 150,000 square miles, a little more than that of the British Isles (see Fig. 23).

In 1923, 10 million acres were alienated, almost wholly in Swanland, 262 million acres of pastoral lands were held under lease, and 335 million acres of the dry or tropical lands were unoccupied.

In this State wheat and oats constitute nearly the whole (97 per cent) of the crops as may be seen from the following table for 1922.

Crops	*Area in Acres*	*Percentage*
Wheat	1,336,000	70
Wheaten hay	222,000	12
Oats	163,000	9
Oaten Hay	113,000	6
Orchards	19,000	1
Green forage	27,000	1
Total	1,880,000	99

The wheat belt receives from 12 to 20 inches of rain and measures about 450 miles from north to south and 30 to 120 miles from west to east. The following notes describe agriculture in the newer wheatlands of Australia:

"Considerable areas of the poorer sand-plain, which are useless for growing wheat, occur in patches throughout the belt. The cost of clearing in this belt usually runs from 15 shillings to 30 shillings an acre. Usually the roots are left in the ground—where they finally decay. The ploughing is done with a stump-jump plough, which rises over obstructions—and greatly reduces the cost of production.

"Seedtime begins about April in the earlier maturing districts, and ends somewhere in

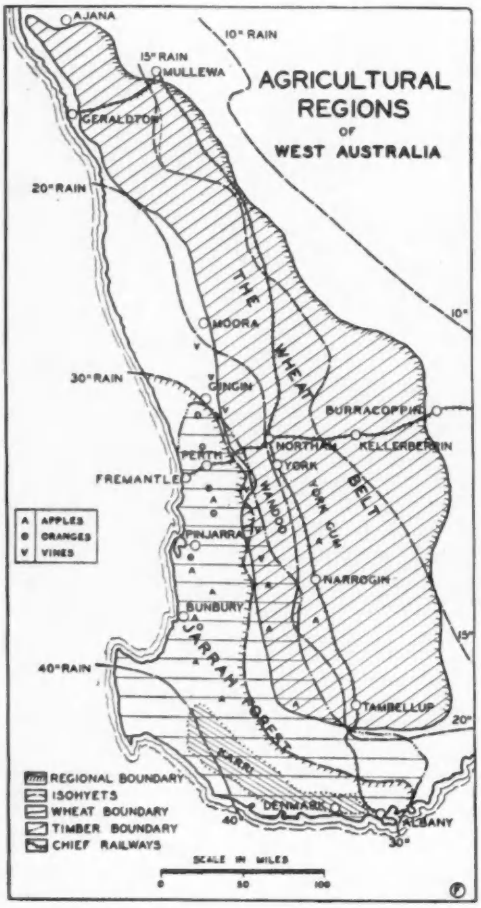

FIGURE 23.—The relationship between rainfall, natural vegetation, and agriculture is probably more clearly illustrated in West Australia than anywhere else in the world. The more humid agricultural section which has been designated "Swanland" has an area of 150,000 square miles, a little more than the British Isles.

June in the later districts. For fertilizers, phosphates are required but the soils usually contain enough nitrogen and potash.

"A typical farm consists of 1,000 acres and the farmer growing from 250 to 300 acres of wheat each year usually gets a crop every two or three years from a given area. Fallowing is managed as follows. The harvest is generally in December. The field is cleared in January and the farmer turns sheep on the stubbles. In May he seeds his next crop on another field previously prepared. He then ploughs the first field any time from June to September while the land is soft from the winter rains, and the weather is cool for his teams. In Spring he works over the surface with a disc harrow, etc., and so obtains a soil mulch. Such a fallow will store up from 3 to 6 inches of rain, and crops seeded in such land are practically independent of early rains. In 1923 the State had 977,000 acres fallowed in preparation for 1924."[8]

Few regions in the world exhibit rainfall controls so clearly—whether we consider the forest belts or the industries which are displacing them. The isohyets run parallel to the coast. Thus, from Perth round Cape Leeuwin to Albany is a strip 40 miles wide receiving more than 30 inches per annum. This was clothed with splendid eucalypt trees of three species—"Tuart" (*E. gomphocephala*) in the north, "Jarrah" (*E. marginata*) in the center, and "Karri" (*E. diversicolor*) in the south, especially where the rainfall increases to 40 inches. The next strip, from 30 to 25 inches, was mapped botanically by a continuous belt of Jarrah, and the next (25 to 20) still farther east by a belt of "Wandoo" (*E. redunca*). From 20 to 15 inches is the habitat of the York gum (*E. loxophlebla*). Here also are found specimens of Mallet, Salmon, and Gimlet gums, which are small trees, but invaluable for mining timbers. These latter grow throughout the drier portions of Swanland.

Karri and Jarrah have a world-wide reputation, and they are exported much more than any other Australian timber. They are greatly used for wood-blocks and piles.

The table on the following page shows concisely how man has adapted these vegetation belts to his needs.

SPECIAL CONDITIONS AFFECTING AGRICULTURE

In a vast new land like Australia where the population is very small,

[8] From notes on wheat by J. W. Paterson in a Government publication.

FIGURE 24.—Jarrah trees, one of the eucalyptus group, the best timber tree in Australia, in the Pemberton district of West Australia. (Courtesy of West Australian Govt.)

the amount of literature bearing directly upon the physical controls governing agriculture is extremely scanty. There are active departments of agriculture controlled by the States and also allied bodies in the universities. But here also the geographical aspect has perforce been neglected. The writer has therefore been compelled to choose certain salient topics, which are far from being exhaustive of the subject, and which, moreover, are in some cases based on conditions found only in one State.

The Great Artesian Basin is of paramount importance in the pastoral lands of Queensland and is first described (Fig. 26). Because of the chief highlands much land in the *humid southeast* is of little use for agriculture. This is the next problem to be treated. Only in New South Wales has anything approaching a soil survey been made; thus, this important topic is only briefly discussed. Irrigation can only occur where permanent rivers flow, and only in the southeast of Australia do these conditions occur in inland areas. The two chief regions are described in some detail. Finally, no geographical discussion of our agricultural pests has heretofore appeared, so that no apology need be made for this preliminary account of the spread of rabbits and other pests.

GREAT ARTESIAN BASIN

Perhaps in only two salient features does Australia stand out in the agricultural world—in her wool production, and in the size of her main artesian basin. The two are rather closely linked together. Thus, in

Region	*Rainfall*	*Vegetation Belts*	*Crop*	*Towns and Mean Monthly Temperature*
A	Over 30 inches Warmer moiety	Tuart and Jarrah	Dairies Vines Oranges Sheep	Perth (January, 74°; July, 55°). Pinjarra.
	Over 30 inches Cooler moiety	Jarrah Karri	Dairies Apples Sheep	Bunbury, Denmark. Albany (January, 66°; July, 53°).
B.	30–20 inches	Jarrah	Vines, some wheat, farms	Gingin.
	20–15 inches	Wandoo York Gum	Great Wheat Belt	Moora, Northam, York, Narrogin (January, 72°; July, 50°).
	15–12 inches	York Gum	Dry Wheat Belt Sheep	Kellerberrin (January, 77°; July, 50°).
C.	12–8 inches	Mallet Gum Gimlet Gum Salmon Gum	Few sheep and Cattle	Carnarvon (80°, 61°), Yalgoo, Southern Cross, Kalgoorlie (77°, 51°).

FIGURE 25.—A karri grove in the wet southwest section of West Australia. The karri trees, said to be the tallest trees in the world, even rivalling the giant sequoias of California, furnish excellent timber. (Courtesy of West Australian Govt.)

1880, Queensland had about 10 million head of stock. Bad drought years followed; yet by 1913 there were 28 million. This increase was due largely to the greatly improved water supply derived from the artesian sources.

In 1885 bores were begun in southern Queensland and water was struck at Thuroolgoona (near Cunnamulla) in 1887. The following bores were completed in 1923.

State	*Bores*
New South Wales	510
Queensland	2,968
South Australia	143
Northern Territory	167
Victoria	347
West Australia	209

Of this total of 4,344 bores, almost all in the first four divisions are in the Great Artesian Basin. (There are smaller basins which supply Victoria, West Australia, and parts of South Australia and New South Wales.)

The Great Basin covers about 600,000 square miles. The deepest water-supply is near the Barcoo River, where it was struck at 7,000 feet. For most of the basin the intake appears to be along the east Queensland highlands, whence the water slowly moves to the southwest. It finally appears at the surface in a series of mound springs which extend all along the margin of the basin in South Australia, especially south and west of Lake Eyre.

In general the temperature of the water increases towards the west; the gradient being 1° increase for 70 feet of depth in the east and about 1° increase for 20 feet in the west. The salinity also increases on the whole towards the outlet, being under 10 grains per gallon in the east and southeast, and over 20 grains per gallon in the west. The chief salt is sodium carbonate and the amount present does not harm stock. (These variations in heat and salinity are not very regular.)

About half of the bores in Queensland are flowing. In the others the water has to be pumped. The average flow of the flowing bores is about one-quarter of a million gallons per day. There is, unfortunately, a general decrease in the water supply of 3 per cent or more per annum. In Queensland 124 bores showed a diminution of 40 per cent in 15 years.

The chief sheep district of Queensland runs from Winton via Longreach to Charleville, that is, right through the middle of the Artesian Area. The bore water flows from the pipes into drains ploughed across the country. These are about a foot across and 10 inches deep. They often lead to dry creek-beds and convert them into small streams, thus giving permanent water to large areas where it was before non-existent. Some of these drains are 20 miles long. Although the water is often used for small gardens attached to "head stations," it has

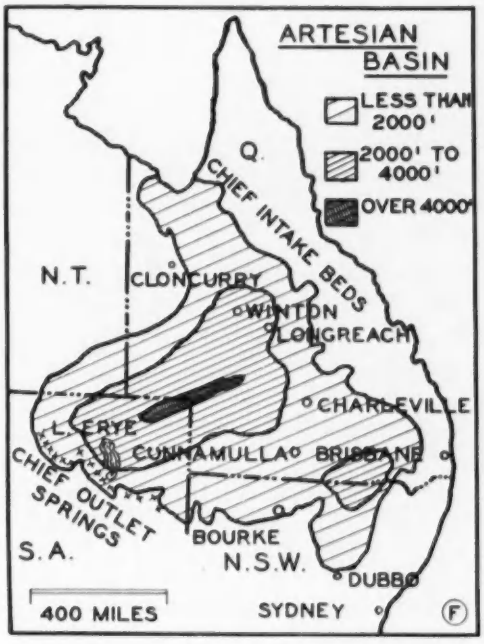

FIGURE 26.—The great artesian basin of eastern Australia just west of the height of land. Its importance to the pastoralist in this section can hardly be overestimated, particularly to sheep-grazing. It is one of the distinctive agricultural features of the continent.

not been found possible to use it for agriculture on a larger scale.

RUGGED AREAS IN SOUTHEAST AUSTRALIA

It is unfortunate for Australia that so much of her best watered land in the East is a region of recently uplifted fault-blocks. As a result the topography is rugged, and this is a notable factor in determining the utilization of the land. It is often difficult to decide why a region in a comparatively newly settled country like Australia remains empty. The haphazard observer declares that given time all will be well; the scientist often deduces that it is due to the inherent poor quality of the region. There are many folk in Australia who are readily satisfied that the Scottish Highlands are empty because of their poor resources, and yet these same folk will not admit that Australia has many large areas as little attractive to the settler and, therefore, never likely to be inhabited to any notable degree.

The accompanying map (Fig. 28) is an attempt to estimate the area of the least attractive portions in the wetter farming belt of New South Wales. The annual isohyet of 25 inches is shown, and a considerable proportion of this wetter area of about 78,000 square miles is still almost as empty as in the time of Captain Cook. (The basis of the chart is a large map showing every post office. There is hardly a settlement in this part of the State without a post office within six miles, and this is the criterion used.)

The New England Plateau of three or four thousand feet is deeply trenched on its seaward face by canyons up to 2,500 feet deep. As

FIGURE 27.—A panorama of the Burrinjuck reservoir, one of the principal irrigation projects in New South Wales. (Courtesy of New South Wales Govt.)

a result while the gentler western slopes are fairly settled, the east, except near Armidale, is nearly empty. The two elevated areas to the west are volcanic ranges with very rugged country.

FIGURE 28.—The least attractive portions of the wetter farming belt of New South Wales are indicated in this map. They represent areas of least favorable relief, soils, and drainage.

The Blue Plateau is built of barren sandstone dissected by wide canyons 2,000 feet deep—but a dozen tourist resorts (near Katoomba) growing up behind the metropolis have cut across this rugged area. In the south Kosciusko (7,328 feet) is a fault-block pushed up 5,000 feet above the general level and very bleak and wet. The Tindery region is probably a plateau scarp akin to that along the east of New England Plateau. Tabulating these areas, one finds

	Approximate Area (Square miles)
Northeast New England	3,700
Southeast New England	5,000
Nandewar Volcanics	1,610
Liverpool Volcanics	1,740
Northern Blue Plateau	4,000
Southern Blue Plateau	1,610
Tindery Scarp	2,750
Kosciusko Plateau	3,000
Total	23,410

Thus, about 30 per cent of the well-watered littoral of New South Wales has not yet been found suitable for notable settlement.

In Victoria only the east center is so rugged. An approximate calculation gives about 13,800 square miles for that part in the Victorian Highlands which is practically uninhabited. Here, also, the rainfall is over 25 inches per annum, and about one-third of such well-watered country in Victoria (as in New South Wales) is so far largely unused.

(Note.— Instalment II will appear in the next issue.)

CANE-SUGAR PRODUCTION IN THE BRITISH EMPIRE

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THE trend of the world's sugar production is steadily upwards, the total having risen from 17.2 million tons on the average of the five pre-war years (1909–1910 to 1913–1914) to 27.2 million in 1928–1929. The increase was almost entirely due to cane sugar, the production of which had risen by 80 per cent, while that of beet sugar had risen by only 4½ per cent. As in production generally, the advance in this period has thus been almost entirely in countries outside Europe. The War and its aftermath of revolution affected particularly severely the European countries that produce beet sugar. Even before the War, Cuba's export surplus had reached the same level as that of Europe—about 2.5 million tons—and Europe's post-war deficiency was Cuba's opportunity, with the result that it has become the leading producer and dominates the open markets of the world. Increase of output occurred, however, at the same time throughout the countries producing cane sugar, and British producers shared in the boom that culminated in 1920. The capacity of the cane-growing regions to respond to the demand proved more than sufficient, and with the revival of European output there has followed a period of overproduction, relative, however, only to the world's present rate of consumption, which is still, owing to the War, below what would have been normal. The resulting period of low prices has led sugar producers throughout the world to seek stability in closer organisation, national and international. This has been one stimulus to the present movement among British producers towards strengthening their position.

Great Britain's Sugar Supply

Excluding British India, Great Britain comes second in the total quantity of sugar consumed only to the United States, its consumption in 1925–1928 being 30 per cent that of America. While, however, American consumption has in recent years increased continuously, that of Great Britain has not yet recovered from the setback received during and immediately after the War. During the War a committee of the Royal Society studied the calorific value of the country's food imports. Calculating on the basis of their statistics, sugar (excluding that used in brewing) made up 13.4 per cent of the total calorific value consumed in the United Kingdom in the period 1909–1913, taken as normal. The following table shows the change that has taken place since then in the source of the raw sugar imported.

Import of Raw Sugar into Great Britain *

1909–1913	*Per Cent*	*1923–1927* †	*Per Cent*
Germany	36	Cuba	35
Java	12	Mauritius	14
Austria-Hungary	11	Peru	9
Cuba	9	Santo Domingo	9
British West Indies (including British Guiana)	6	British West Indies (including British Guiana)	8
Mauritius	4	Java	6

* Accounts relating to the trade and navigation of the United Kingdom.

† From 1923 onwards British statistics exclude the Irish Free State.

As for refined sugar, Germany and Austria-Hungary supplied 41 per

cent and 21 per cent in the pre-war period, while in the post-war period Czechoslovakia supplied 34 per cent, the Netherlands 30 per cent, the United States 14 per cent, and Canada 10 per cent.

The danger of dependence on Europe in time of war for supplies of raw or refined sugar became one of the arguments of those who wished to encourage production in British possessions overseas. To discuss the validity of this argument is outside the scope of this article.

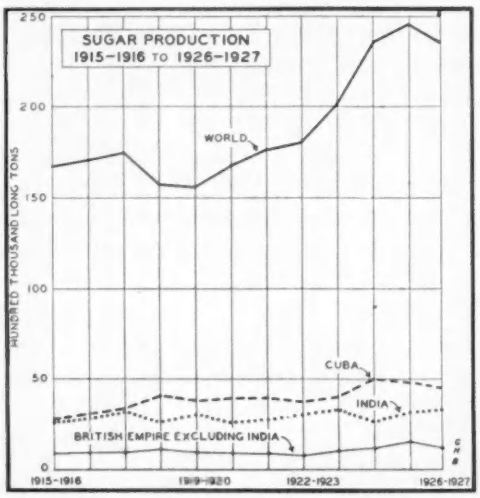

FIGURE 1.—How little of the sugar production of the world comes from the vast possessions of the British Commonwealth of Nations is strikingly revealed by this chart. (Sources: *Statistical Abstract for British Empire; World*, Willett and Gray; Cuba, *Facts about Sugar*.)

Preference for Empire sugar had been urged on behalf of the producers by an organised body since 1916, when there was formed a section of the British Empire Producers' Organisation devoted entirely to the encouragement of sugar production within the Empire. This body has since grown into the Sugar Federation of the British Empire, formed in 1927, of which the main objects are "to increase and improve production in the British Empire and secure for producers terms in all Empire markets at least as favourable as those accorded by foreign countries to

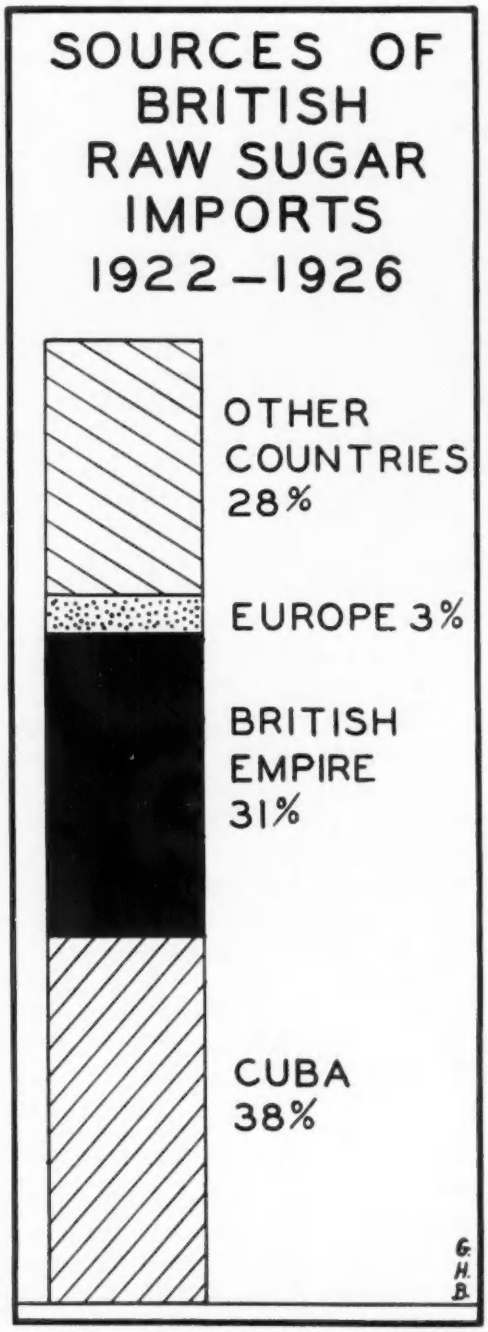

FIGURE 2.—The far-flung states of the British Commonwealth of Nations supply less than one-third of the imports of sugar into Britain.

FIGURE 3.—Mauritius: Unloading the cane from railway trucks at the factory. The Government railways are largely used for cane transport. (Courtesy of Miss M. Freeland.)

their National and Colonial producers, and to arrange that wherever possible such terms shall take the form of money value preferences in import duties stabilised for a period of years." In furtherance of this policy its programme includes not only the organisation of propaganda but the encouragement of technical research. Funds are being provided by a voluntary levy of six pence per ton of sugar produced, already agreed on by Australia, Natal, and Mauritius.

From 1874 to 1901 Great Britain had a "free breakfast-table" as far as sugar was concerned, there being no duty of any sort in this period. In the latter year, however, a revenue duty was imposed, subsequently reduced, and then raised again during the War to an unprecedented level. In 1919 the preferential principle, too, was introduced for the first time, in favour of the colonial producers. This preference, for which a minimum at the rate of 4s. 3⅓d. per cwt. for sugar exceeding 98° polarisation was stabilised in 1925 for a period of ten years, was raised in 1928 to 6s. $10^{8}/_{10}$d. on sugar exceeding 98° and not exceeding 99°, and 5s. 10d. on sugar exceeding 99°, on a gross duty of 11s. 8d. on all sugar exceeding 98°. Complete remission of duty on Empire sugars is now the avowed aim of the Sugar Federation.

IMPORTS OF RAW SUGAR TO GREAT BRITAIN FROM BRITISH EMPIRE *
(In thousands of long tons)

	1923	*1924*	*1925*	*1926*	*1927*	*Average*	*Per Cent of Total Import*
Mauritius	223	124	85	204	194	166	14
British West Indies	99	56	129	99	94	95	8
Australia	8	44	89	151	82	75	6
Natal	29	8	36	58	44	35	3
Total import	1,168	1,170	1,335	1,069	1,175	1,183	....
Per cent from Empire	33	25	25	48	35	....	....

* Annual statement of the trade of the United Kingdom, etc., and accounts relating to the trade and navigation of the United Kingdom.

CANE-GROWING REGIONS OF THE BRITISH EMPIRE
PRODUCTION OF RAW CANE-SUGAR IN THE BRITISH EMPIRE
(In thousands of long tons)

	1921–1922	*1922–1923*	*1923–1924*	*1924–1925*	*1925–1926*
British India *	2,614	3,045	3,317	2,546	2,977
Australia	300	306	286	436	522
British West Indies	274	273	256	285	295
Mauritius †	193	224	198	220	236
Natal ‡	132	142	181	144	214
Fiji	72	35	64	100	71
Total British Empire, excluding India	971	980	985	1,185	1,338
Total British Empire, including India	3,585	4,025	4,302	3,731	4,315
Total world	17,615	18,120	20,115	23,641	24,609
British Empire, Per cent	20	22	21	16	17

* Indian statistics are particularly unreliable, and in any case are not strictly comparable with others, as they refer only to a crude form of sugar.

† Mauritius statistics, usually given in metric tons, have been here converted to long tons.

‡ Natal statistics, usually given in short tons, have been here converted to long tons.

In 1913 the proportion of Empire sugar in the total British import of raw sugar was only 7 per cent, so the advance since the War has been considerable.

Roughly, one-fifth of the world's sugar is thus produced within the British Empire. The above statistics of production take no account of the beet-sugar production in British countries, but this is a comparatively insignificant figure, and would raise the British proportion only very slightly. The large production of India is entirely consumed within its own boundaries, India being an importer of sugar. Although before the War that country was the world's greatest producer, with 14 per cent of the total in the five pre-war years, its rate of increase was already lagging behind that of the world, while Cuba's was outrunning the latter.

Although the British cane-growing regions are widely scattered, there are sufficient points of resemblance in their conditions and problems to make possible a certain unity of treatment in discussing them, especially when India is excluded. That this is so, is, of course, not only partly dependent on the inevitable similarity in the demands of the cane plant wherever it is grown, but also on several features common to the economic development of these tropical or subtropical lands.

CONDITIONS OF PRODUCTION OF SUGAR CANE

The climate most suitable for sugar cane is hot and humid.

Climate

As for temperature, the absence of frost is particularly desirable, as frost lowers the sugar content and

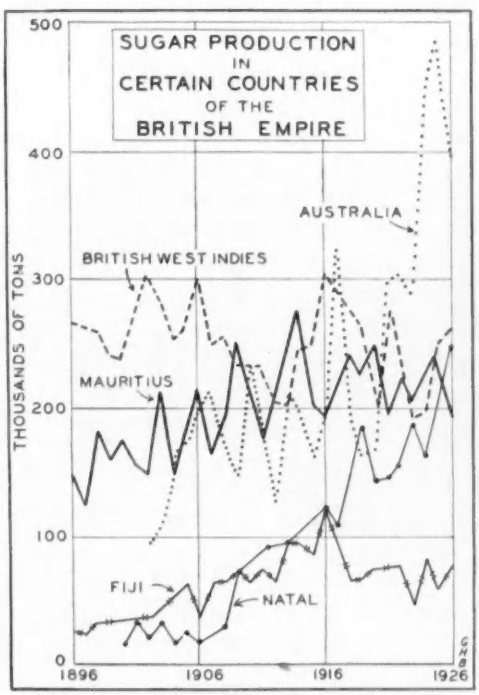

FIGURE 4.—Sugar production is declining in the British West Indies; holding steady in Mauritius and Fiji; responding rapidly to protection of domestic markets in Natal and Australia. For Mauritius the statistics are in metric tons; for the other countries, in long tons. (Source mainly *Statistical Abstract for British Empire.*)

FIGURE 5.—A typical landscape in the sugar regions of Fiji. Mulching the soil between the rows, and destroying weed growth by modern disk cultivators on the Navatu Estate, Rarawai, Fiji Islands. (Courtesy of Colonial Sugar Refining Co., Ltd., Sydney.)

decreases the purity of the juice. The rainfall régime allowing the best yields of sugar is one in which there is a well-marked alternation of wet and dry seasons, the wet summer allowing rapid growth and the drier and rather cooler season favouring increase of sugar content. So, the sugar-cane lands lie in the tropical or sub-tropical zones of summer rain. While total annual precipitation can only be a very general index, the minimum desirable is, as a rule, 40 inches; on the other hand, excessive moisture lowers sugar content and gives scope for fungoid diseases.

FIGURE 6.—The sugar estates of British Guiana are on the flat alluvial land mainly within six miles of the sea and to a large extent below the level of Ordinary Spring Tides. (Courtesy of "Empire Production," published by the British Empire Producers' Organisation.)

Soil

The cane generally thrives best on a loam or well-drained clay. The most popular cane soils in the British regions, as elsewhere, are the red

FIGURE 7.—In British Guiana, the drainage canals are used for transporting the cane to the factories, by iron "punts" hauled by mules. (Courtesy of "Empire Production," published by the British Empire Producers' Organisation.)

soils, fertile, and having great moisture-retaining capacity combined with easy drainage. Their comparative ease of cultivation is of the greatest economic importance. On the other hand, the rapidity with which leaching occurs leads to a growing demand for fertilizers in order to raise the level of yields. In practically all the regions deficiency in organic matter is one of the most serious problems.

Labour

Cane growing is voracious in its demand for labour, much of it exceedingly arduous. No matter how up-to-date mechanically an estate may be, much manual labour is still absolutely essential for cultivation and for harvesting. The cutting of the cane is an operation that still defies the machine-maker, and is not only extremely arduous but must also be performed rapidly in order to avoid deterioration in the cane juice and to keep the mill running at maximum capacity. Labour shortage, which is general in the Tropics, thus becomes particularly acute in the sugar industry. The immigration of labour into the sugar lands has, indeed, already a long history behind it. The sugar islands of the West Indies were, in fact, the first tropical lands to adopt this remedy on a large scale when they began to import slaves from West Africa in the fifteenth century. The abolition of slavery in British lands in 1834 cut away the labour basis of the sugar plantations both in the British West Indies and Mauritius and led to the widespread emigration of East Indians, mainly from the Upper Ganges Valley and Madras, as indentured labourers to the sugar colonies. The East Indian has been, and still is, the backbone of the British cane-sugar industry. Indentured immigration

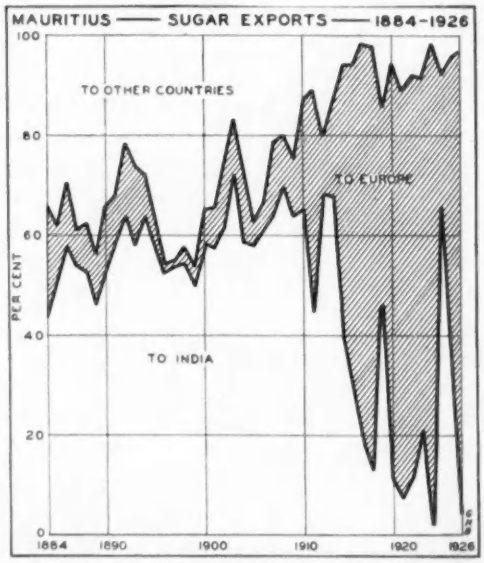

FIGURE 8.—The proportions of Mauritius sugar export shipped to India and to Europe indicate how proximity to a favourable market for long affected the shipments.

to Mauritius began in 1834 and lasted until 1910; in the British West Indies it continued from 1836 to 1917; in Natal from 1860 to 1911; in Fiji from 1879 to 1916. The indenture system came to an end because of the growth of opinion in India unfavourable towards it. Nevertheless, an East

FIGURE 9.—Cutting sugar cane in Jamaica where negro labour plays a relatively greater part in the sugar industry than in other portions of the British West Indies. The machete or short cutlass is shown. (Courtesy of West India Committee, London.)

Indian population remains in these countries, forming in 1921 in Mauritius 71 per cent of the total population, in British Guiana 42 per cent, in Fiji 39 per cent, while in Natal it outnumbers the whites. The indenture system, while it lasted, had many weaknesses, such as the small proportion of women introduced, a mistake that, through the resulting slow natural growth of the immigrant population, has accentuated the labour shortage resulting from the abolition of the system. In Australia indentured labour consisted of Kanakas, natives of the Polynesian islands, introduced from 1864 to 1904; the problem there is peculiar, since the sugar industry now depends mainly on white labour.

In the countries of East Indian labour, given the very slow natural growth of the immigrant populations, labour shortage on the sugar estates has inevitably arisen with the increasing tendency of the East Indians either to take up small holdings or move to other industries. In Mauritius, in Fiji, and in some of the British West Indian islands, a class of peasant planters has arisen, which, however, owing to its lack of capital, the smallness of its holdings, its personal inefficiency, its slowness in adopting agricultural improvements, and, in some cases, its insecurity of tenure, has been unable to compensate by its efforts for the correspondingly smaller area of operation of the estates. In Mauritius about one-

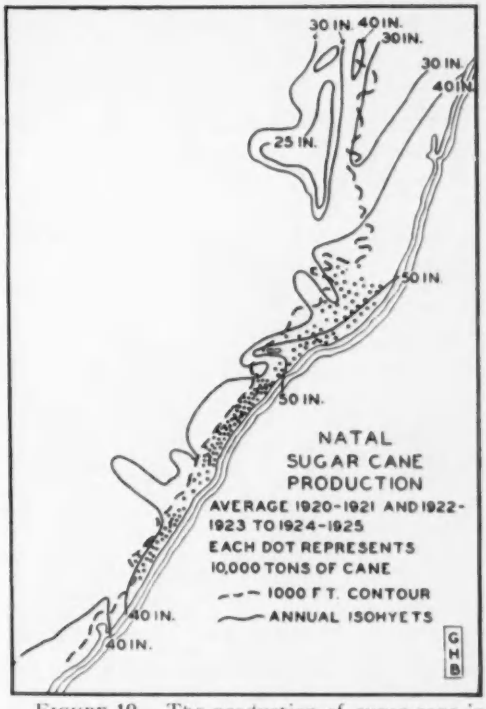

FIGURE 10.—The production of sugar cane in Natal is confined almost entirely to the coastal belt. (Annual isohyets from Irrigation Department's Map by A. D. Lewis.)

half of the cane land is now in the hands of the East Indians; in Fiji over half of the estates owned by the company controlling sugar production there have been parcelled out to East Indian tenants, and there are many independent small planters on the outskirts of the estates; and in Trinidad at least 60 per cent of the

"cane-farmers," mainly annual tenants, are East Indians. In Mauritius and Trinidad agricultural credit societies are assisting the movement.

The evolution of a community of small but efficient peasant planters must needs be slow. Meanwhile, the most generally adopted measure towards relieving the labour shortage is increased mechanization of the estates. The steam-plough and the motor-tractor are being gradually introduced throughout the British cane regions. A development of a quite different nature, that is of growing importance for the sugar industry as well as for other tropical industries, is the increasing attention given by the governments, as well as by many

FIGURE 11.—Cleaning dense scrub in the tropical rain forest section of Queensland preparatory to clearing it by fire. The sugar fields of Australia are nearly all won from such lands as these. (Taken from "Queensland Sugar Industry," published by the Intelligence Bureau, Brisbane, Queensland, 1913.)

large estates, to measures of public health. The two greatest drags on the physical efficiency of tropical labour are malaria and hookworm, both especially prevalent in cane-growing districts by the very nature

FIGURE 12.—Primitive sugar culture; planting with mattock on scrub land recently cleared. (Taken from "Queensland Sugar Industry.")

of these. The latter is prevalent in all the regions concerned, but the vigorous campaign against it, initiated throughout the Tropics by the Rockefeller Foundation, is already showing results. Many of the governments are also taking energetic measures against malaria, in Mauritius especially.

AGRICULTURAL RESEARCH

While labour shortage is still a great hindrance to improved methods of cultivation, the problem of increasing output per acre and per head is being approached from another direction in the breeding of improved varieties of cane. Higher-yielding canes, resistant to disease and adapted to local conditions of climate and soil, offer great possibilities. In the British West Indies, British Guiana and all the islands have their own agricultural departments, naturally devoting special attention to cane, while since 1922 the Imperial College of Tropical Agriculture in Trinidad, the first in the chain of research stations proposed to be established in the British Tropics,[1] has also devoted attention to sugar problems. In British Guiana, besides the sugar experiment station

[1] See Report of Imperial Agricultural Research Conference, 1927.

FIGURE 13.—Planting by hand in open furrows in land only recently wrested from the forest. (Taken from "Queensland Sugar Industry.")

maintained by the local government, the planters run one with the assistance of a Government subsidy. The Imperial College is supported by voluntary contributions from the separate Colonies in the West Indies, in addition to having received financial aid from the Imperial Government. In Mauritius, where sugar has recently occupied up to 80 per cent of the cultivated area, the local Department of Agriculture inevitably devotes most of its energies to the crop. The industry in Natal has maintained a research station since 1926, while in Queensland the Bureau of Sugar Experiment Stations controls three stations, with two subsidiary entomological stations, all subsidised by the State Government. India has the famous sugar research station at Coimbatore. In Fiji the controlling company pursues an active research policy. In the British West Indies the seedling canes first produced in Barbados have now replaced the formerly predominant Bourbon. The movement towards coöperation in agricultural research generally has, in the last few years, received a great impulse, particularly by the meeting in London in 1927 of the first Imperial Agricultural Research Conference.

DEVELOPMENT OF THE RAW SUGAR FACTORY

On the manufacturing side the evolution in recent years has been towards the "central" raw sugar factory, drawing its cane from a very extensive area and having an annual output of up to 100,000 tons or more of sugar. Cuba, where this evolution has proceeded farthest, has peculiar advantages, natural and financial, in all forming a complex of favourable conditions that cannot be approached within the British Empire. Factory conditions in the British countries show great local variation, but in most cases there are great obstacles, physical as well as financial, to the evolution of the large-scale unit, with

FIGURE 14.—Machine planting supersedes hand planting on tracts which have been cleared for several years. Much of the labour on the sugar plantations is done by Italian immigrants. (Taken from "Queensland Sugar Industry.")

the economic advantages it possesses. The sugar industry in the British colonies has not attracted British capital as that of Cuba has attracted American. The history of the industry makes the reasons obvious.

CLASSIFICATION OF CANE-SUGAR PRODUCING COUNTRIES OF THE BRITISH EMPIRE

The cane-sugar producing countries of the British Empire may be primarily grouped as "surplus" or "de-

ficiency" countries, and, secondarily, according to the degree to which the complex of their present conditions of production makes them suitable for the industry. From these considerations there emerges the following economic classification:

A. Surplus countries
   1. Conditions well-suited to sugar-production; normally able to compete in the free market.
      (a) Mauritius.
      (b) Fiji.
   2. Conditions unsatisfactory, but industry persisting, with tariff assistance.
      (a) British West Indies.
   3. Conditions definitely marginal, and industry being carried on only by means of a high degree of protection in the internal market and tariff assistance for exports.
      (a) Australia.
      (b) South Africa.

B. Deficiency country
   (a) India.

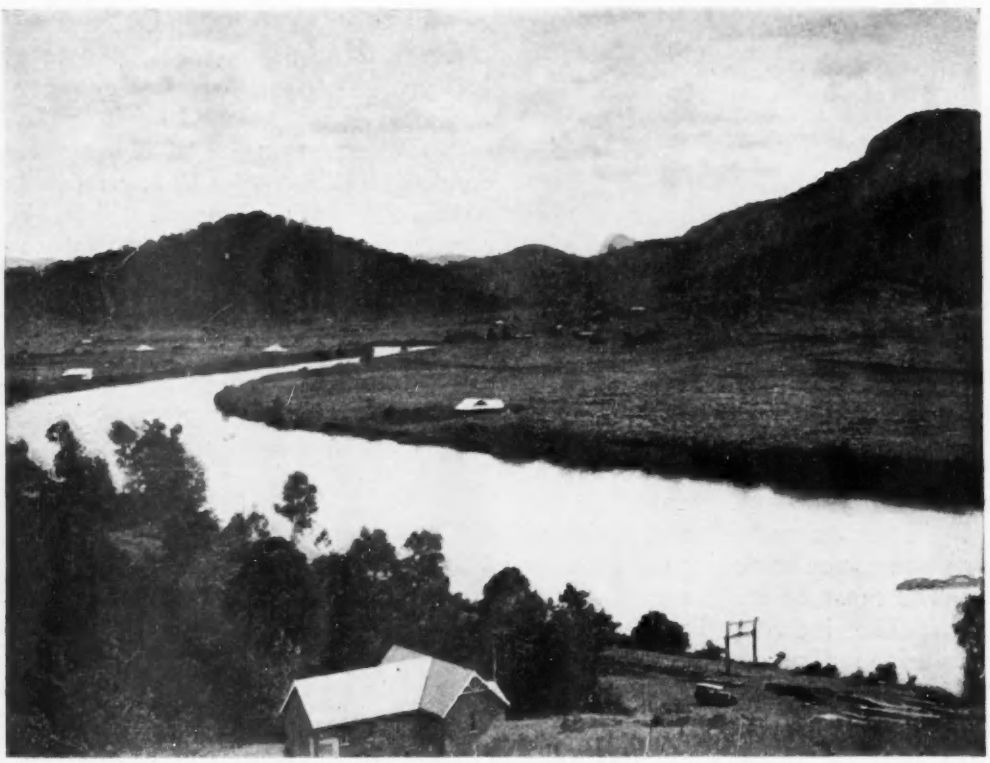

FIGURE 15.—Sugar farms on the Maroochy River, Queensland. The cane is grown mainly in the river valleys, the relief of the cane belt being very irregular. (Courtesy of Development and Migration Commission, Commonwealth of Australia.)

(A) MAURITIUS

(1a) Mauritius, Great Britain's island possession in the South Indian Ocean, was the first to rival the West Indies as a source of sugar for the mother country, having sent sugar regularly for more than a century. It is now, after a long interval of supplying the Indian market, the leading source of Great Britain's imports from within the Empire, practically the entire output being so ab-

sorbed. A large part of the island is covered by the fertile red soils, particularly in the southeast, where the chief producing districts are, and where too the climate is particularly suitable. Only occasionally do hurricanes pass near enough to cause serious damage; serious droughts are, however, still rarer. Mauritius has factories making further improvement in efficiency difficult.

(A) FIJI

(1b) In the Fiji Islands, the chief group in the South Pacific, cane is grown on the alluvial coastal flats and in the lower parts of the valleys, chiefly on the leeward side, on the

FIGURE 16.—Sugar cane cutting, Queensland. Cane cutting in Queensland is performed by white labour organized in gangs. (Courtesy of Commonwealth of Australia, Development and Migration Commission.)

become a one-crop country, the best lands being already occupied by cane, much further extension being impossible. The island enjoys freedom from serious cane disease, the chief need on the agricultural side being measures to counteract the labour shortage, while on the manufacturing side further concentration of production is desirable, the relatively large number of small-scale two main islands—Viti Levu and Vanua Levu. While production is only about one-third that of Mauritius, it is exceptionally well organized, being controlled by a single company, owning five mills and the transport system of the colony. The company relies for its profits chiefly on its large refining business in Australia and New Zealand, Fiji having the advantage, unusual among British sugar

colonies, of considerable financial resources behind the industry. The rapid introduction of machinery and the encouragement of coöperative cane farming are going far to solve the labour problem. The sugar is exported mainly to New Zealand, the Australian market being closed by an embargo on sugar produced by coloured labour. New Zealand, however, though it has a very high per capita consumption, has a small population and so offers only a limited market, but in recent years the British preference has enabled part of the surplus to be exported to Great Britain.

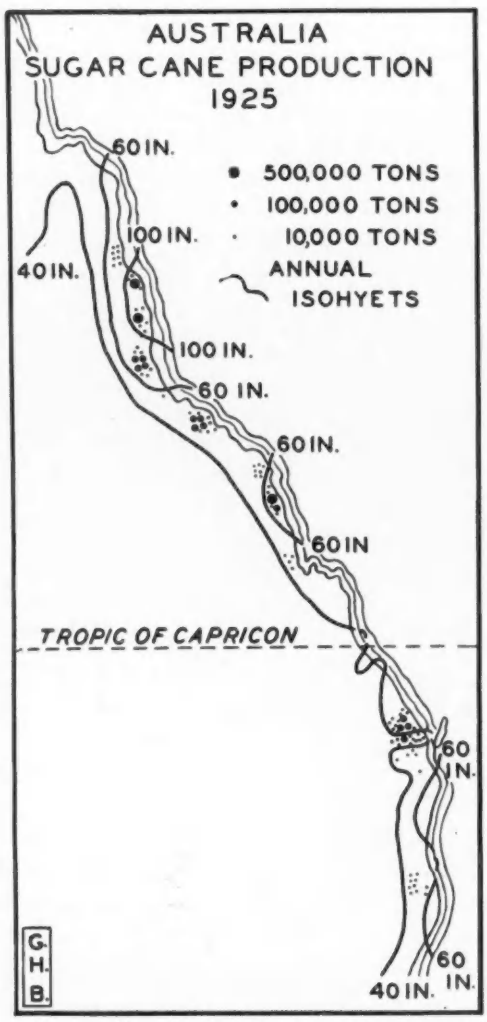

FIGURE 17.—It is on the warm, damp, coastal border of Queensland that most of the Australian sugar is produced.

(A) BRITISH WEST INDIES

(2a) The British West Indies, Great Britain's "classical" sugar colonies, are on the whole climatically suited to sugar cane, though Barbados and the Leewards, for instance, approach marginal rainfall conditions. Their soils vary from the light, easily-worked red soils of Barbados to the heavy alluvial clays of British Guiana. The "sugar islands" occupied a key position in the economic organization of the Old Colonial Empire. With the nineteenth century came disaster to the planters. First, the competition of slave-grown sugar cane when the system of slavery had been abolished in the British colonies, but this competition was surpassed in the latter half of the century by that of European beet sugar. By 1897, when the intervention of the Imperial Government brought a turning-point in British West Indian history, the area under sugar cane had shrunk to its smallest dimensions. Since then, however, a number of expedients have enabled the industry to survive, and, while in some areas the decline has continued, in others there has been a slight expansion on the low level with which the century ended. They are as follows:

(1) Sugar cane has been, to an extent varying in different colonies, confined to the areas where climate and soil are best suited to it. This process, which has gone farthest in Trinidad,[2] has helped to improve the economic position.

[2] See James, P. E., ECONOMIC GEOGRAPHY, January, 1927, "A Geographic Reconnaissance of Trinidad."

FIGURE 18.—A Queensland sugar mill. The cane is transported to the mill on narrow gauge railways. In this type of factory with several floors, advantage is taken of gravity in passing the material from one stage of manufacture to another. (Courtesy of Commonwealth Immigration Office.)

(2) Closely connected with the above has been the adoption or extension of other crops better adapted to local conditions and to the needs of the world market. Instances are the banana in Jamaica, cacao in Trinidad, and coconuts, cotton, and limes in Antigua and St. Lucia. In some smaller islands there has also been increased cultivation of "ground provisions." This process of diversification has brought satisfactory results, both agriculturally and financially.

(3) In Jamaica, specialisation on a by-product, rum, has done much to keep land under cane, though it has led to the neglect of efficiency in sugar production in the factory. Elsewhere, by-products are of secondary importance, though British Guiana still has a large rum export and Barbados now commands the market for fancy molasses.

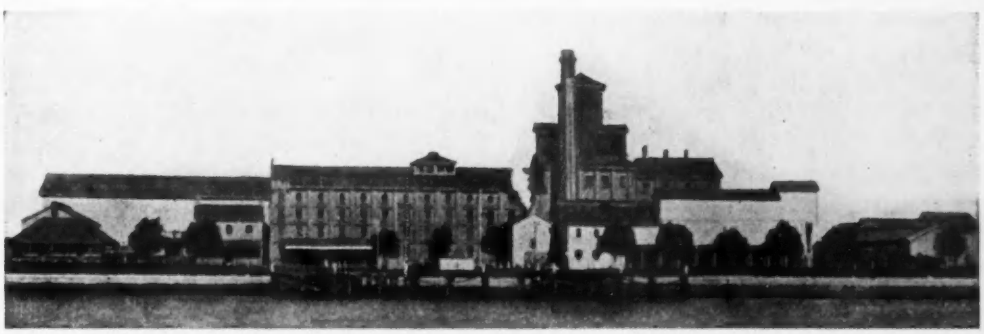

FIGURE 19.—Colonial Sugar Refining Company's refinery, New Farm, Brisbane. (Courtesy of "Queensland Sugar Industry," published by the Intelligence Bureau, Brisbane, Queensland, 1913.)

(4) Until the Cuban Reciprocity Treaty of 1903 the American market was the chief outlet for British West

FIGURE 20.—Earthing up cane with the Sabul plough in India. (Courtesy of Trade Commissioner for India, London.)

Indian sugars, their position being strengthened by the American countervailing duties on bounty-fed sugar. In 1903 the Brussels Convention brought some relief in the British market, and meanwhile, since 1898, Canada had begun to give a preference, since then increased and embodied in a series of trade agreements, the latest of which, in 1925, gives a preference at the rate of $1.00 per 100 pounds for sugar over 95° and not over 96° polarisation. The British preference since 1919 has, of course, greatly strengthened such assistance.

(5) The high prices of the years immediately following the War helped the industry.

(6) Added to these influences has been a sort of inertia that has helped many old and sometimes unprogressive estates with family traditions to keep going through a prolonged period of depression, whereas greater enterprise would have caused the abandonment of the sugar industry for some more profitable activity.

These various influences together have just enabled the industry to survive. It is still faced with great difficulties, encountered here in an accentuated form. On the agricultural side, the shortage of labour is particularly acutely felt in British Guiana and Trinidad, their heavy soils requiring much cultivation. On the manufacturing side, not only financial difficulty but physical conditions, such as the small size of some islands or, as in Jamaica, the scattered distribution of the cane lands and difficulties of transport, are great obstacles to "centralization." At the same time, while the British areas can never hope to have "centrals" on the Cuban scale, considerable advantage has been derived from efficient factories of a more modest size, examples of which are in Trinidad, Antigua, St. Kitts, and Jamaica.

(A) NATAL AND QUEENSLAND

(3a and 3b) In Natal the sugar belt stretches along the coast as far south as 31°, while in Australia the long-drawn chain of cane districts

AVERAGE EXPORT FROM BRITISH WEST INDIES, 1922–1926 *

	Sugar (1,000 tons)	*Rum* (1,000 gals.)	*Molasses* (1,000 gals.)
British Guiana	89	710	4,667
Trinidad	51	46	877
Barbados	44	14	6,655
Jamaica	37	778	...
St. Kitts-Nevis	12	...	329
Antigua	11	...	257
St. Lucia	4	...	147
St. Vincent	..	...	257
British West Indies, total	248	1,548	10,028

* Statistics from the annual reports of the colonies concerned.

FIGURE 21.—Small iron cane crusher now largely used in India. Driven by bullocks. (Courtesy of Trade Commissioner for India, London.)

stretches along the Queensland coast to 30° S. In the southern parts of both regions temperature is distinctly marginal, frosts causing considerable damage, particularly in Australia. In both the 40-inch isohyet marks the lower rainful limit of most of the cane land, but in Australia there is sufficient cane grown beyond this limit in the south to make losses severe in a dry year. In both regions the centre of production is, in fact, tending northwards. Not only are considerable parts of these regions marginal climatically, but also are they, as a whole, severely handicapped in their labour conditions, Australia peculiarly so. In Natal, since the breakdown of the East Indian indenture system, the industry has depended mainly on Bantu Negroes, 75 per cent of whom now have to be drawn from other parts of the South African Union. Not only is this labour insufficient in quantity, but also is it unsatisfactory in quality. Australia, since it expelled most of the Kanakas in 1906, has, in order to carry out its policy of a "White Australia" by settling a white population along the hot and humid Queensland coast, placed very severe restrictions on the employment of coloured labour. No white man may employ coloured labour in cane-cutting, nor may it be employed in cultivation on ploughed land on any farm with over 75 acres under cane. As the white cane-cutters receive relatively high wages compared with those paid in other sugar-producing regions, the costs of production are very high. At first the industry was assisted by a bounty; later it was protected by a high tariff. This was not satisfactory, so ultimately the entire prohibition of import was found necessary. Natal sugar has protection in the South African market of £7 a ton. But, in both cases, these highly-protected internal markets are limited in extent, and both industries are faced with the problem of disposing of an export surplus. Only by means of a British preference maintained at a high level can they do so without serious loss, especially on Australia's part.

(B) INDIA

(a) In India 90 per cent of the cane is grown in the Indo-Gangetic Plain, that is, mainly outside the Tropics. Over half the area is in the United Provinces. There is a smaller pro-

FIGURE 22.—Old style of very inefficient wooden bullock mill in India. Wooden bullock mills were used for extracting the juice from the cane. Such mills lost in the Megass over 30 per cent of available juice in the cane. (Courtesy of Trade Commissioner for India, London.)

duction in the Peninsula. Despite India's great output, second only to Cuba's, the crop in no part attains great relative importance, even in the United Provinces occupying less than 4 per cent of the total cultivated area. The climate in general is not favourable, the growing period being short, though hot and, in some provinces, humid. To enable cane to establish itself in the preceding hot, dry season, irrigation is necessary. In the extra-tropical area only the hard, thin North Indian canes mature, but there irrigation is cheaper and the light alluvial loams are relatively easily worked, though the red and black soils of the Dekkan give higher yields per acre. Not labour shortage but labour inefficiency is the chief hindrance to progress, which is, generally, however, bound up with the whole extremely complicated problem of improvement in Indian agriculture. Of the sugar produced, 99 per cent is in the form of "gur," which is simply cane juice concentrated until it is solid, practically without purification. The very low productivity per head of population makes a large import necessary, and the value of the sugar import, which is mainly from Java, is surpassed only by that of the cotton piece-goods imported.

Largely as a result of the encouragement given by the Imperial Government to British producers, the proportion of British raw sugar imports from within the Empire, which had been 11 per cent in 1909–1913, had reached 49 per cent in 1926. What are the permanent prospects of such supplies? Does the geographical background exist in the British sugar-producing regions for the economic progress of the industry? As for the first question, the surplus countries with the most favourable conditions of production—Mauritius and Fiji—are those which are nearest the limits of their potential cane land. The British West Indies are unlikely to sacrifice the advantages of such diversification as has already been carried out, even if further help from the Imperial Government were to alleviate their difficulties in sugar production. Natal and Australia, which have considerable areas of potential cane land at their disposal, can utilise it only at the cost of

FIGURE 23.—India: Making gur, unpurified cane-juice, concentrated to solidity. Ninety-nine per cent of the sugar made in India is in this form. (Courtesy of Trade Commissioner for India, London.)

further lowering their average returns and at the risk of further loss in disposing of the export surplus. In every instance the future of economic production rests with the raising of average yields in field and factory, that is, in intensifying production rather than in extending the area under cane and, given the geographical conditions of the British sugar-producing regions, the proportion of British sugar in the imports of Great Britain may in this way be increased, at least cost to the consumer and taxpayer, and with the minimum of opposition.

RAINFALL AND WIND CONDITIONS RETARDING TROPICAL DEVELOPMENT

Stephen S. Visher
Geographer, Indiana University

DURING the last two centuries white man has occupied nearly all middle latitudes. The chief exceptions are the parts occupied by the Japanese and Chinese, where, nevertheless, Western civilization has penetrated notably. In contrast to this conspicuous success in middle latitudes is comparative failure in the tropics, where there are very few white families and where white man's civilization has made relatively little impression.

Introduction

Can white man and his civilization spread into the tropics and occupy it successfully? White man is said to be at the crossroads; his progress during recent centuries has been very rapid, but now the future seems dark to many observers. Yet, nearly a quarter of the land of the world is almost unused, and that quarter receives the most energy from the sun, and much of it receives considerable rainfall, or has other valuable assets.

The failure of white man to occupy any considerable share of the tropical half of the world is not due to any single factor, but to a combination of unfavorable conditions. Some of these unfavorable conditions have long been recognized; others have only recently been appreciated; perhaps some are still unsuspected. If white man is to succeed in his efforts to effectively use the resources of the tropics, careful study must be made of all the factors operating. This calls for specialization and cooperation.

The purpose of this article is to call further attention to and discuss the baneful influences of certain aspects of the rainfall and winds which have retarded tropical development. However, in order to give proper prospective, it seems desirable to briefly consider other conditions which have interfered with white man's occupation.

Other Deterrents to Civilization in the Tropics

The high death rate prevalent in the tropics has been a powerful factor, by destroying many of those who have gone, and by discouraging others from going. Although yellow fever and malaria have been largely conquered, and other diseases reduced, the death rate as of a normal (unselected) population still remains high. This casts doubt upon the optimism of those who have assumed that the conquest of the tropics can proceed rapidly as soon as methods of successfully combating important tropical diseases have been discovered and applied.

Ellsworth Huntington has discovered that the optimum temperature for man's physical activity and especially for his mental activity is considerably below that characteristic of tropical lowlands. How detrimental this is cannot now be determined. Neither can one now discover how much of a handicap are the relatively small ranges of temperature from day to day and from

season to season, also suspected by Huntington of being significant.

Several other conditions have been recognized as having contributed to white man's failure in the tropics. One of these is the presence in humid regions of a superabundance of wild animal and plant life. Animals of all sizes attack man and his domesticated plants and animals. Some of the larger wild plants serve as weeds, crowding cultivated plants, or soon blocking trails and roads. Some of the smaller plants (bacteria, moulds, fungi) induce disease and decay. Another unfavorable condition is the relative infertility of the soil in the rainier regions, except on areas often flooded by streams or slope wash. Other exceptions are scattered areas where removal is rapid enough to expose unleached, fertile materials, but slow enough to permit a considerable depth of soil to persist.

The presence of a native population which lives on a low social plane has also been unfavorable to white man's civilization, for such a population furnishes cheap servants, but leads to physical labor being despised, and to other unfortunate conditions. It powerfully retards or prevents the development of a large, thoroughly substantial, middle-class white population.

The ideals of the people who have gone to the tropics have also been blamed for white man's failure there; for most men have gone to the tropics to exploit the resources and natives, having no intention of making a real home. Few women have gone, and most of those have led a highly artificial life, because of their attitude toward life in the tropics, and their numerous servants. In brief, home life comparable to that prevalent in mid-latitudes has seldom been attempted in the tropics; admittedly, without real home life, occupation cannot be successful.

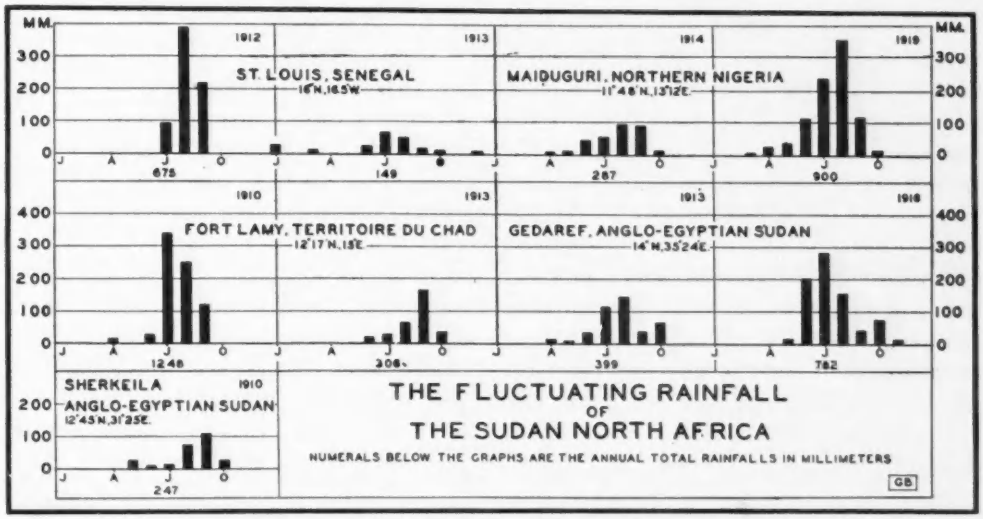

FIGURE 1.—Some variations in the annual rainfall of the North African Sudan. (Data from G. T. Renner, *Geographical Review*, October, 1926.)

IMPORTANCE OF A FULLER KNOWLEDGE OF CLIMATIC CONDITIONS

The foregoing conditions unquestionably have retarded the spread of

white man's civilization into the tropics. They may even prevent the development of an indigenous, permanent civilization of high order. But, sufficient knowledge and capital, and their adequate use, may overcome these handicaps sufficiently to enable white man to develop the resources of the tropics even if he can not build up a civilization comparable to that of mid-latitudes. In order, however, to develop tropical resources without enormous waste of effort, capital, and life, climatic conditions must be well understood. Most of the published data deal with averages, but averages have little significance; life is affected by actual conditions, not by averages. Two climatic conditions of great significance are rainfall dependability and wind storms. These conditions have been studied in widely separated sections of the tropics by the present writer who is convinced that they are important deterrents to tropical development. Strange to say, both have been largely ignored in spite of their importance and the fact that data for their evaluation is available, or may be readily gathered.

RAINFALL DEPENDABILITY: ITS IMPORTANCE

As precipitation is essential to farming, stock raising, and many other human activities, its dependability is of vital importance. Nowhere is a uniform amount received in corresponding seasons year after year, but in some regions the supply is much more dependable than in others. The regions of greatest dependability are the humid sections of mid-latitudes, especially those characterized by frequent changes of weather, caused by the passage of numerous cyclonic disturbances, the lows of which induce rainfall. Furthermore, in mid-latitudes during the colder season, considerable periods with slight precipitation cause little damage. In contrast, in the tropics it is warm throughout the year, and evaporation is rapid, partly because on the average, the warm air there can hold three times as much moisture as can the cooler air of mid-latitudes.

ERRATIC RAINFALL OF ARID REGIONS

All arid regions are characterized quite as truly by highly erratic as by scanty average rainfall. From time to time rainy spells, usually "cloudbursts," produce striking effects. Train service is most frequently interrupted by floods in arid regions, partly because proper provision against flood waters has been hard to make. Many a shallow valley which today seems entirely innocent, or to require merely a culvert, tomorrow may be filled with a raging torrent requiring a wide bridge.

Warm deserts are especially subject to wide fluctuations in rainfall. For example, Helwan, Egypt, has received eighteen times as much rainfall in one year as another, and Onslow, a small port of tropical Western Australia, forty-seven times as much. Even greater extremes are recorded in regions where occasionally a year passes with no rainfall at all, as in Sonora, northwestern Mexico, and in tropical Chile. In northern Chile and southwestern Peru, although several years without rain sometimes occur, nevertheless continued and heavy rainfall is also known occasionally. This was true in 1925, 1918, 1891, and from time to time as far back as written records or legends go. The character of the older sedimentary deposits show that such alternations of extreme drought and con-

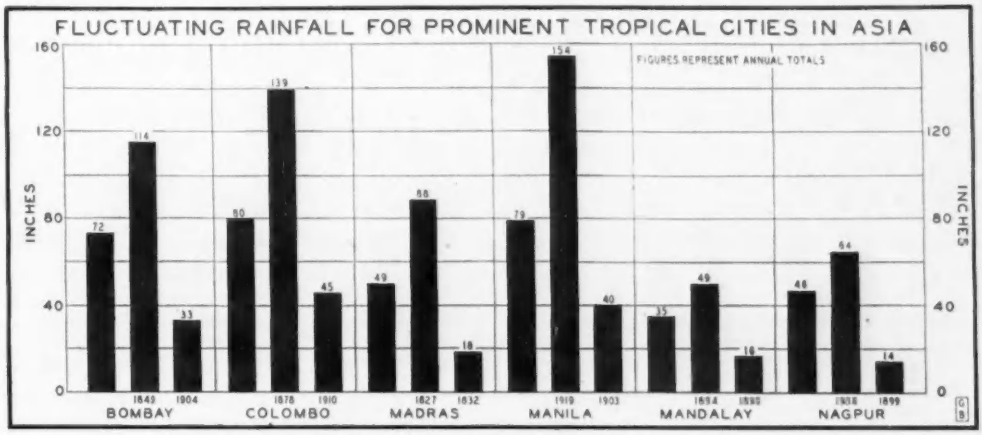

FIGURE 2.—The distinctive wide fluctuation in tropical rainfall is clearly revealed by this chart of several representative cities of Asia. (Data mostly from World Weather Records, Smithsonian Institution, 1927.)

siderable rainfall have persisted for geologic ages. The floods of 1925 caused great damage to towns, crops, native birds, and other life not adjusted to rainy conditions. Much valuable nitrate and guano fertilizer which had accumulated during the preceding rainless period was washed into the sea by the floods. Furthermore, the guano-yielding sea birds were greatly reduced in numbers by the destruction of eggs by the rain and by the death of adults by disease. Diseases spread because the changed temperature conditions in the Humboldt Current, which induced the abnormal rainfall, were fatal to many of the fish which form the chief food supply of the birds.

FLUCTUATING RAINFALL OF SEMI-ARID REGIONS

In semi-arid regions, fluctuation of rainfall has greater economic consequences than in arid, because in semi-arid regions in an average year, numerous livestock can be grazed, and in good years the yield of crops may be excellent. Hence, human occupation is invited, and the losses during dry years are much greater than in arid regions, which, except where irrigated or mineralized, never support many people or stock. For these reasons, drought causes much greater loss in eastern Australia, where the rainfall averages over fifteen inches, than in the drier section. The losses would be even greater if the Australians did not have the ability, knowledge, and capital to adjust their activities rather well to the fluctuating rainfall. In the Sudan of North Africa and in much of South Africa, the erratic rainfall frequently causes much loss of life and property. Another tropical semi-arid area which suffers frequently and severely from drought is northeastern Brazil.

UNDEPENDABLE RAINFALL IN THE WET TROPICS

The indications are clear, moreover, that in even the rainier tropical regions the rainfall is decidedly undependable. Illustrations of the fluctuations at certain tropical cities and areas are given elsewhere, but may be summarized here. Among scattered low latitude cities having thirty inches or more a year, on the average, in no case was the officially

recorded rainfall of the wettest year less than twice that of the driest. Only in Calcutta, India, and in Caracas, Venezuela, did the ratio fall as low as 2¼. In Johannesburg, South Africa, it was 2½ times as great; in Durban, South Africa; Hongkong, British China; and New Orleans, Louisiana, it was about 2¾ times as great. In Colombo, Ceylon, and Honolulu, Hawaii, it was about three times; in Bombay, India, and Manila, Philippine Islands, each about 3½ times; in Madras, India, 4½ times; in Brisbane, Queensland, and Singapore, Straits Settlements, five times; and Forteleza, Brazil, six times. Equatorial Ocean Island (longitude 169° E.) received eight times as much rain in 1905 as in 1909 (19.6 inches vs. 158.9 inches); Malden Island (latitude 4° S., longitude 155° W.) 2,000 miles east of Ocean Island, received sixteen times as much rain in 1905 as in 1908 (3.9 inches vs. 69.4 inches). The average rainfall for each of these places is over thirty inches and the mean for the group is 58 inches. The records are of varying length, but in most cases not long. Indeed a five- or ten-year record for a tropical station generally includes a year having more than twice as much rainfall as the driest year.

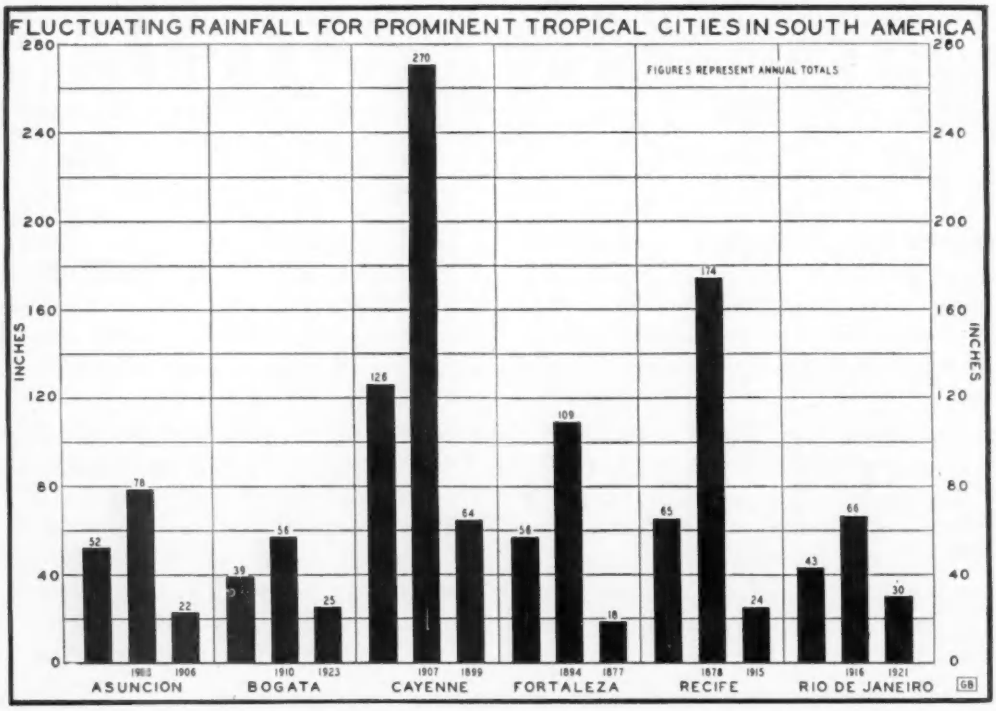

FIGURE 3.—South American cities reveal the same fluctuation in rainfall as do the tropical cities of other lands. (Data mostly from World Weather Records, Smithsonian Institution, 1927.)

In contrast, the much longer records of many mid-latitude cities fail to reveal any such extremes in rainfall. For example, the maximum rainfall received in any year since the records commenced, many decades ago, at Chicago, Edinburgh, Oslo, Ottawa, Paris, Peking, and Tokyo was less than twice the minimum

rainfall. It was only a trifle more than twice the minimum in the case of Amsterdam, Berlin, Berne, London, New York, Leningrad, St. Louis, and Wellington, New Zealand. The records of some of these cities extend over two centuries.

That the contrast in rainfall dependability illustrated by these cities, selected solely because data for them were available, is not local is suggested by various data. For example, the average rainfall of the entire Hawaiian group (150 stations) was more than twice as great in 1919 as in 1918 (112.9 inches compared with 54.5 inches). In the Philippines also, according to Coronas, droughts generally affect the whole archipelago. Likewise in Cuba, 19 scattered stations had an average rainfall of twice as much one year as the next (75.3 vs. 36.6 inches). Yet, the rainfall of Cuba is characterized by Dr. Fassig, U. S. Meteorologist for the West Indies, as notably dependable, especially in the warmer months, as compared with other West Indian Islands. In 28 years (1899 to 1924) the average summer rainfall of Cuba ranged 16.3 inches (from 11.6 to 27.9 inches), and for the six warmer months (April to September) it ranged 19.7 inches (from 27.9 to 47.6 inches).

In contrast to these Hawaiian, Philippine, and Cuban conditions, comparison may be made with the rainfall dependability of Indiana, a state comparable with Cuba in area and average rainfall. The same 28-year period includes no year when the average rainfall for Indiana departed as much as nine inches from the normal amount (39.2 inches). During the three summer months the extreme range at Indianapolis was seven inches, in contrast with 16.3 inches for Cuba. During the warmest six months it was 10.9 inches, or only slightly over half Cuba's range.

Many of the detrimental effects of wide, erratic fluctuations in the rainfall are obvious. The dry spells commonly result in reduced yields of crops, of grass for grazing animals, and of water supply for man and beast. Often the spread of disease is facilitated by the weakened conditions, due to partial starvation. Sometimes the abundance of mosquitoes is increased by the converting of former streams into series of stagnant pools. The periods of excessive rainfall are less obviously detrimental, but nevertheless cause much harm by interfering with commerce, farming, and other outdoor work, by causing floods which injure roads and bridges and by stimulating the growth of weeds and other rank vegetation. That acceleration of vegetative growth of cultivated crops is by no means uniformly desirable is proved by the reduced sugar content per acre of cane in wet years, and the spread of wilt in the tobacco, and the deterioration of bananas.

The uncertainty of financial returns which results from the relatively erratic rainfall of the tropics has deterred numerous capable northerners from exploiting the tropics; for capable people wish to be reasonably sure of at least a fair return for their efforts.

UNFAVORABLE SEASONAL CONCENTRATION OF RAINFALL

Another great aspect of tropical rainfall which is detrimental to tropical development is the large extent to which it is concentrated in certain seasons. This concentration is well known, as even in the elementary schools children are taught that the seasons of the tropics are

"wet" and "dry" rather than "summer" and "winter." The detrimental effects of such a rainfall distribution are not, however, adequately realized. The high tropical temperatures induce such rapid evaporation that soon the soil is parched, roads and fields become very dusty, vegetation withers. Indeed in a large share of the tropics, the vegetation, except where irrigated, is largely dormant during

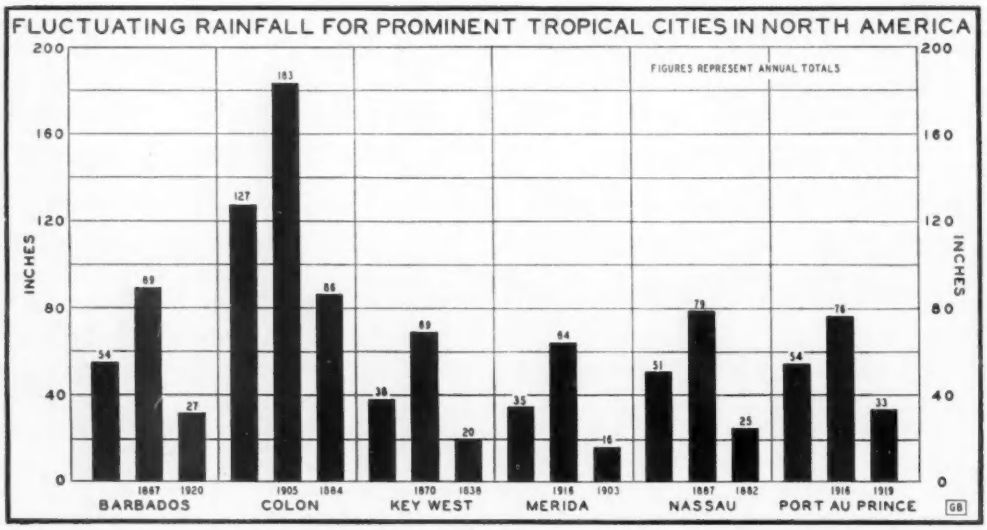

FIGURE 4.—The typical fluctuation of the rainfall of tropical cities in North America is illustrated by this chart of data from six representative cities. (Data mostly from World Weather Records, Smithsonian Institution, 1927.)

much of the dry seasons. Streams cease to flow, the water-table falls; water supplies for man and beast become limited and contaminated, and death rates rise. During the wet season, however, the rain often is so abundant as to produce a "sea of mud," swollen streams, excessive atmospheric humidity, and other unfavorable conditions.

TORRENTIAL CHARACTER OF TROPICAL RAINFALL

Tropical rainfall is not only erratic and largely seasonal, but is characteristically torrential. Instead of falling gently as is usual in middle latitudes, most tropical rains are of the thunderstorm type, with large drops and a copiousness unknown in cooler regions. There are innumerable tropical stations with records of a fall of more than ten inches of rain in twenty-four hours, many with over twenty inches, dozens with over thirty inches, six of over thirty-five, and three of over forty inches in twenty-four hours. The world record for twenty-four consecutive hours is forty-six inches, near Manila; but several widely separated tropical rainfall stations have received more than forty inches within forty-eight hours. In other words, excessive falls within short periods are of greater magnitude and are more frequent in the tropics than in middle latitudes. All of the records of thirty inches or more of rainfall within twenty-four hours are from tropical latitudes, as are nearly all records in excess of ten inches. In the

United States, in contrast, in twenty years the only areas receiving over ten inches in twenty-four consecutive hours were along the Gulf Coast. No area in the northern third of the country received over six inches, while nearly five-sixths of the northern border had an extreme maximum of less than four inches.

The detrimental effects of such "cloudbursts" as are frequent in the tropics are largely obvious. When as much rain falls in a day as most of the middle latitudes receive in a month or even in a year, much soil washes away, many roads and trails are damaged, and a severe strain is imposed on all structural evidences of civilization, such as buildings and sewers.

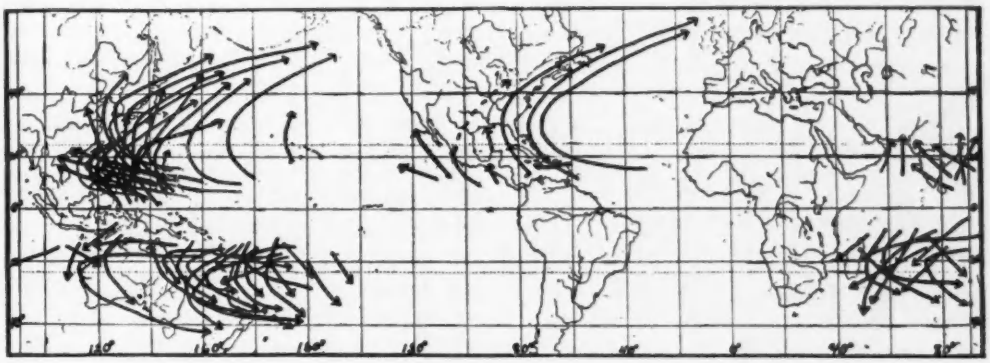

FIGURE 5.—Sketch map showing tracks of the tropical cyclones (hurricanes, typhoons, and gale-producing cyclones) of an average year. (Original.)

SHARP LOCAL CONTRASTS IN RAINFALL

A fourth feature of the rainfall conditions in the tropics which interferes with tropical development is its relative localization. In many parts of the tropics there are such sharp local contrasts as to interfere seriously with land utilization. In many areas where the relief is not more than a few hundred feet, one place receives more than twice as much rain as another place close at hand. This is especially true where mountains are near, but it is also true in some regions which lack real mountains, northeastern Queensland and northeastern Brazil, for instance. The city of Honolulu may serve as an illustration: Within four miles from the central weather bureau station with its thirty-one inches of average rainfall are long, reliable records of less than twenty-five inches (in the lee of Diamond Head) and over ninety inches (nearer the mountains, but still almost at sea level).

Where sharp local contrasts in average rainfall obtain, the areas best adapted to a particular crop variety commonly are small and widely scattered, and it is hard to fit crop to rainfall type. The Hawaiian Sugar Planters Association, for example, is experimenting with several hundred varieties of cane in an effort to find the best variety for each combination of rainfall and soil. This is a tremendous undertaking for even so rich and scientific an organization, but is almost an impossibility for an individual, who can scarcely hope to find more than a fair fit. Similarly, dwellings, equipment, and methods that are satisfactory in one place often are misfits only a short distance away.

WIND STORMS AS RETARDING INFLUENCES

Civilization is so frail that it is injured by strong winds. As wind storms are especially severe and widespread in the tropics, and as various conditions are unfavorable to preparation to withstand them, wind storms deter civilization there much more than in mid-latitudes.

THUNDERSTORM SQUALLS

According to C. E. P. Brooks, more than a thousand thunderstorms occur each day somewhere in the tropics. Most of them are more severe than the average thunderstorm in the United States, and many are accompanied by violent squalls, which are made the more powerful by the greater deluge of rain. The damage done to vegetation is suggested by the prevalence of ragged banana leaves, of partly lodged sugar cane, and of fallen trees across roads and trails. The lightning accompanying tropical thunderstorms is also often much more intense and terrifying than with our storms.

TORNADOES AND RELATED STORMS

Whirling winds often accompany severe thunderstorms and frequently, even in America, it is not easy to distinguish between such a whirl and a weak tornado. Such transition storms appear to be especially frequent in tropical Africa, but they are rather frequent in many other tropical areas. Full-fledged tornadoes, comparable to the average tornado of the United States, are also experienced in most tropical regions, including Australia, India, the East Indies, and South America. Violent dust whirlwinds of almost tornadic force are not very rare in the Sahara and other tropical deserts. Water spouts, tornadoes over the sea, or, in other cases, convectional disturbances related to dust whirlwinds, are fairly frequent in the tropics.

TROPICAL CYCLONES: HURRICANES AND TYPHOONS

Although the wind storms already mentioned are not by any means trifling, they affect only small areas, and hence are much less significant than the large tropical cyclones which commonly badly damage a belt a hundred miles wide and several hundred miles long.

The existence of violent tropical cyclones has been known for a long time: Columbus encountered one on his second voyage. Their severity and destructiveness have often been described. They kill every year or two, thousands of people in densely populated southeastern Asia and hundreds in the West Indian region. The property loss in the West Indies is millions of dollars a year, on the average. Repeatedly most of the homes in large areas are unroofed, or demolished. The crops grown in the stormier regions are increasingly those which recover soonest from wind damage. Cane, which largely recovers in two years, tends to replace bananas and coconuts which recover much more slowly. Jamaica, for some years the leader in bananas, lost leadership because for three successive years hurricanes did much damage. That tropical cyclones have deterred the spread of white man's civilization has long been realized. However, their importance as a deterrent has not been generally appreciated because they were thought to be much rarer than they are, and because various harmful effects, es-

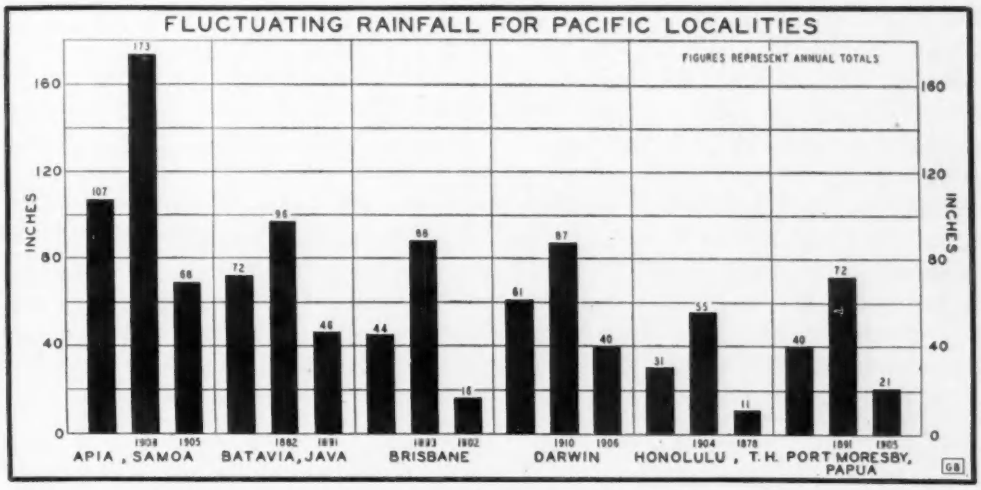

FIGURE 6.—Six cities upon the Pacific reveal the same wide fluctuations in climate as the rest of the cities of the world in the same kind of region. (Data mostly from World Weather Records, Smithsonian Institute, 1927.)

pecially indirect effects, were ignored. It therefore is appropriate that a brief statement be made as to their frequency and as to some usually ignored detrimental effects.

Instead of being rare phenomena, once in years, as many have assumed, upwards of forty hurricane-producing storms occur each average year somewhere in the tropics and perhaps twice as many gale-producing storms. The western Pacific has most, apparently having about one-half of the annual total of recorded storms. But, as the storminess of other sections of the tropics is studied, the predominance of the longer well-known western North Pacific decreases. For example, whereas in a treatise published in 1913, a summary of the tropical cyclones of the world ignored those of the southern hemisphere and showed the Far East as possessing nearly two-thirds of the world's tropical cyclones, data now available indicate that the typhoons of the Far East comprise less than one-third of the world's tropical cyclones.

On the average, about three hurricanes and two gale-producing cyclones occur yearly in the region of the West Indies, two hurricanes and three cyclones occur off the west coast of Mexico and Central America, two and four in the central North Pacific, thirteen and twelve in the eastern North Pacific, five and ten in the South Pacific, five and eight in Australia, eight and five in the South Indian Ocean and four and eight in the North Indian Ocean.

The approximate distribution of the tropical cyclones of an average year is shown in Figure 5. This sketch map shows no destructive cyclones very near the equator except in the Philippine region, because they occur there only rarely, not each average year. However, very severe cyclones are experienced occasionally almost under the equator in the Pacific and East Indian regions, and in Africa. Another necessary omission from this sketch map is the occasional storm which travels on a very abnormal course.

The harmful effects of tropical cy-

clones are by no means limited to the direct effects of the wind, the feature usually emphasized. Tropical cyclones caused most of the excessive rainfalls mentioned on an earlier page. During the four days required for a tropical cyclone to pass, eighty-eight inches of rain fell near Manila, in the Philippines, and 96.5 inches at Silver Hill, Jamaica (B. W. I.), and 77.3 inches at Cromhurst, Queensland, Australia. In three days, as a cyclone passed, 81.5 inches of rain fell at Funkiko, Formosa, Japan, and sixty inches at Mt. Molly, Queensland. There are numerous records of more than twenty-five inches of rainfall during the passage of a cyclone. Such downpours, besides causing serious floods, damaging roads, irrigation works, and railroads, erode the soil very badly on even gentle slopes. The heavy rain also influences the amount of uprooting of trees. Certain tropical trees, such as the coconut palm, usually can be bent until the top touches the ground, without breaking or uprooting. However, if the soil has been thoroughly soaked, uprooting is much more easily accomplished. The rapid run-off sometimes results in torrents sweeping down shallow depressions which rarely carry much run-off.

Another effect of tropical cyclones which is often overlooked is the great waves caused. Waves dash with great violence upon the shores and often reach heights of fifteen feet above normal sea level and not rarely twenty-five feet. There are, indeed, a number of records of hurricane waves reaching a height of forty feet above sea level. Harbors are often impaired by such waves, both by the damage to wharves and docks, and by the partial blocking up of the channel, by great blocks of coral, wrecked ships, or drifted sand.

The sudden coming of great waves drowns many people upon low coasts and along the lower stretches of river valleys. Sometimes, indeed, the water advances as a wall-like wave several feet in height, from which escape is very difficult. Most of the more than 30,000 persons destroyed by the Swatow, China, typhoon of August 3, 1922, drowned, as the general sea level rose eight feet, and great waves rolled over the lowlands, two reaching twenty-five feet above normal sea level. Drowning also caused the death of most of the 200,000 persons reported killed by the Calcutta hurricane of October 3, 1876.

The "mountainous" waves caused by the hurricane winds often damage ships, dashing over the decks, often sweeping away part of the equipment, such as lifeboats. The passage of high waves under the boat repeatedly exposes the propellers, causing them to "race" badly. Since the sudden speeding up of the propellers, when they are lifted into the air, and their equally sudden slowing down when they are again covered with water, subjects the machinery and engine to great strains, it is necessary to run the engine at greatly reduced speed, or even to shut down entirely when the waves are especially bad. Another way in which the waves injure ships is by wrenching them badly. Ships are sometimes broken in two by being suspended between two great waves, or by having the ends unsupported. Others are injured by having their engines and boilers displaced by the violent rolling and pitching of the ship and the shiftings of the cargo. Even the strongest boats are also likely to be driven ashore, if not far from land.

OTHER INDIRECT EFFECTS OF TROPICAL CYCLONES

Disastrous tropical cyclones unquestionably have tended to increase the inertia, fatalism, and communism of tropical peoples. Nothing is quite so deadening to ambition and so unfavorable to persistent effort as the conviction that one's endeavors are likely to be in vain. Devastating tropical cyclones have rendered in vain innumerable efforts. They help produce lassitude, "laziness," and carelessness because from time to time they make the hardest working individual or family as poor in worldly goods as the laziest. They also increase fatalism by their strange partiality. Some houses are destroyed while similar ones close at hand escape; some coconut trees are broken or uprooted while nearby ones survive; many persons are killed while others escape almost miraculously. These differences are mostly due to the varying strength of local gusts of wind or to differences in soil or run-off waters, none of which are apparent to most observers, and hence the result is to increase fatalism and superstition. Even rather intelligent whites have illustrated this to the author. One said: "If it is your turn, you will be caught anyhow, no matter what you do," and another, that he intended to sell out and leave the tropics soon, for he had noticed that "Whenever a white man tries to become very rich in the Pacific Islands, a hurricane comes along and makes him poor again." Communism is encouraged by the gratuitous redistribution of remaining property which is logical after a severe storm.

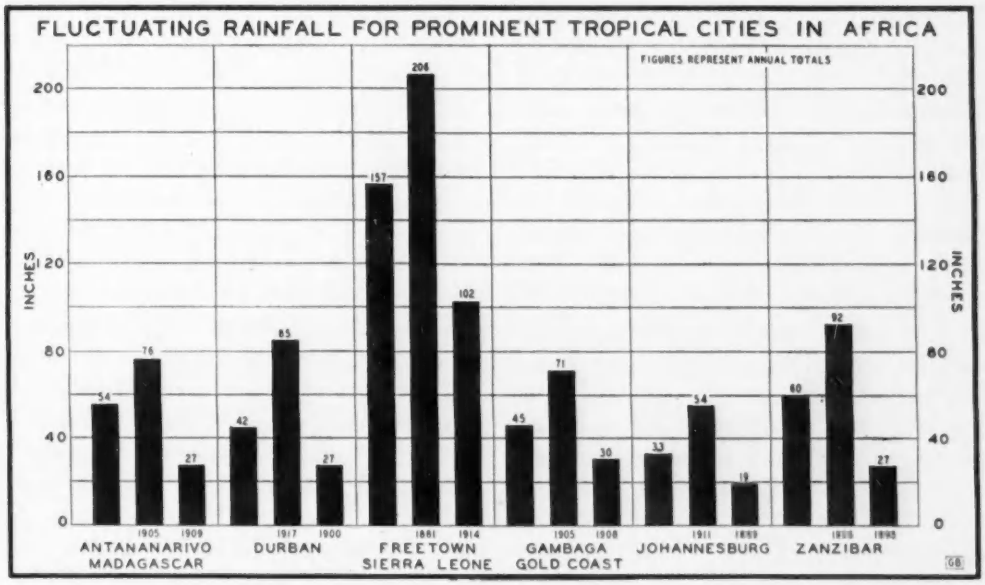

FIGURE 7.—If further evidence were needed of the wide fluctuations in tropical rainfall, the cities of Africa would furnish ample. (Data mostly from World Weather Records, Smithsonian Institute, 1927.)

The discouragement caused by destructive cyclones coöperates with other influences to create additional undesirable conditions. Instead of a well-balanced development with

diversified agriculture and manufacturing for the local market, generally chiefly export products that are especially and quickly profitable are produced. Exploitation rather than wise utilization prevails. Also, instead of comfortable permanent dwellings, the tendency in areas often damaged by storms is to make cheap, temporary improvements. Instead of constructing expensive good roads, the tendency is to get along with cheap trails, for even the most carefully constructed roads are badly damaged by the torrential run-off characteristic of hurricanes. Bridges suffer correspondingly, and, as a result, commonly are mere makeshifts.

The white people of tropical regions frequently lament these conditions and try to improve them, but the pressure brought by distant investors and friends interferes. Investors in tropical regions demand large dividends partly because they fear storms, and hence do not approve of expensive improvements. Even strong local governments have great difficulty in borrowing at reasonable interest rates to make needed improvements and repairs to storm-damaged roads, bridges, and harbors, partly because of the uncertainty as to how long the proposed improvements will serve, before another storm demolishes them.

Disease is increased in several ways. Few people eat or sleep sufficiently while the "blow" lasts, often two or three days; their diet suffers long afterwards, because of the injury to food plants. Many thousands have died of starvation, or of diseases which in their weakened condition they were unable to withstand. Disease also increases with the mosquitoes that develop in the water holes, washed by the torrents produced by excessive rainfall. Healthfulness is affected also by the location and character of the houses, both of which often reflect the fear of storms.

HURRICANES AND THE RACE PROBLEM

The hurricanes have supplemented other conditions in discouraging sufficient white colonization to furnish the required tropical labor. Hence, white exploiters of tropical resources have imported negroes and later coolies from India, China, and Japan. Overpopulation of tropical lands by colored people has been encouraged by white overseers who, with few exceptions, are far more interested in securing cheap labor than in elevating the laborers. Cheap labor is conducive to large profits, and large profits are demanded by investors, partly because of the considerable hurricane risk. Overpopulation is encouraged by the high temperatures and ease of obtaining a mere livelihood; but it is also encouraged by the low property standards which prevail partly because of hurricanes. The gradual improvement of the home, and accumulation of equipment and small savings that have done so much to lead to a fairly high standard of living in mid-latitudes, are greatly discouraged in the tropics by destructive hurricanes, as well as by other causes.

CONCLUSION

Thus, it appears that the development of the tropics is rather seriously interfered with by certain rainfall and wind conditions, and that before the tropics can be developed advantageously, rainfall and wind conditions must be well known, and adjustments to them wisely worked out. Some adjustments which appear essential

are: The location and construction of buildings so as to reduce their damage from floods and hurricane winds and waves to a minimum; storm, drought and flood warnings as far in advance as possible; insurance against unavoidable conditions; diversification of production; and the use of more capital and science. Obviously highly civilized man can cope with the numerous problems of the tropics far better than less advanced people. Indeed, the natives of the tropics have, unaided, made little progress. Hence, fuller utilization of the great tropical resources awaits carefully planned, well-financed, and concerted attempts by the people of mid-latitudes. Such attempts will be made when the tropics, in spite of their handicaps, afford greater opportunities for capital, labor, and intelligence than are available in middle latitudes. Large rich companies with widely separated holdings and a variety of products, for example, the United Fruit Company of the Caribbean region, have decided advantages over the individualist type of development. Indeed, it appears that such well-managed corporations offer the best prospects of successful development of the tropics, although mid-latitudes have been best developed by individuals. Unless extensive governmental aid is given, as in Queensland, relatively few individuals can cope successfully with the numerous difficult conditions in most of the tropics.

AGRICULTURAL REGIONS OF NORTH AMERICA

Part VIII—The Pacific Subtropical Crops Region

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THE Pacific coast is a unique part of North America—in mildness of climate, in magnificence of scenery, in majesty of forests, in kinds of crops grown, and, to a lesser extent, in the character of the people and their attitude toward life. Passing over the mountains from the hot Imperial Valley, occupying the Colorado River delta, with its cotton and cantaloupes, grown largely by aid of Mexican labor, to San Diego and Los Angeles, with their balmy and equable climate, their art and culture, is like going from Egypt to Italy. Likewise, climbing over the mountains from Reno, Nevada, to Sacramento and San Francisco, is almost like an airplane trip from Angora, Turkey, to Milan and Bordeaux, but briefer. Farther north, the traveler crossing the Cascade Mountains from the Yakima or Wenatchee valleys to the Puget Sound cities will find the change in climate as great as in going from Tashkent to Liverpool or Glasgow, but the trip requires only a few hours. Still farther north, traveling from Edmonton, Alberta, to Prince Rupert, British Columbia, is like a journey from Samara or Kazan, U. S. S. R., to the west coast of Norway.

The Pacific coast of North America, like the Atlantic coast of Europe, has a climate greatly influenced by the adjoining ocean; but, unlike Europe, a high and practically continuous mountain range restricts, largely, the marine influence to a narrow belt of land and makes the transition very abrupt. The winters along the Pacific coast are mild and moist, while the summers are cool and dry—cooler than in the eastern United States, except in the interior valleys of California which are very warm, and drier than in either the eastern United States or western Europe, owing to the low Coast Range precipitating a portion of the moisture in the ocean winds.

As a consequence, the crops along the Pacific coast are somewhat different from those in the Eastern States and more like those of Europe, particularly in the Pacific Subtropical Crops Region, which, in this respect, may properly be called the North American Mediterranean Region. One-third of the winter vegetables produced in North America, two-thirds of the oranges, over three-fourths of the grapes, prunes, and figs, and practically all the lemons almonds, and apricots are grown in this region. Also, like the Mediterranean Region, it is a great winter playground for many thousands of people from the colder Eastern and Northern States; and, much more than the Mediterranean lands, it is a region of retirement for those past the prime of life, particularly those who are financially able to spend their declining years in the snowless and sunny climate.

The Pacific Subtropical Crops Region is confined to the valleys of Central and Southern California, and

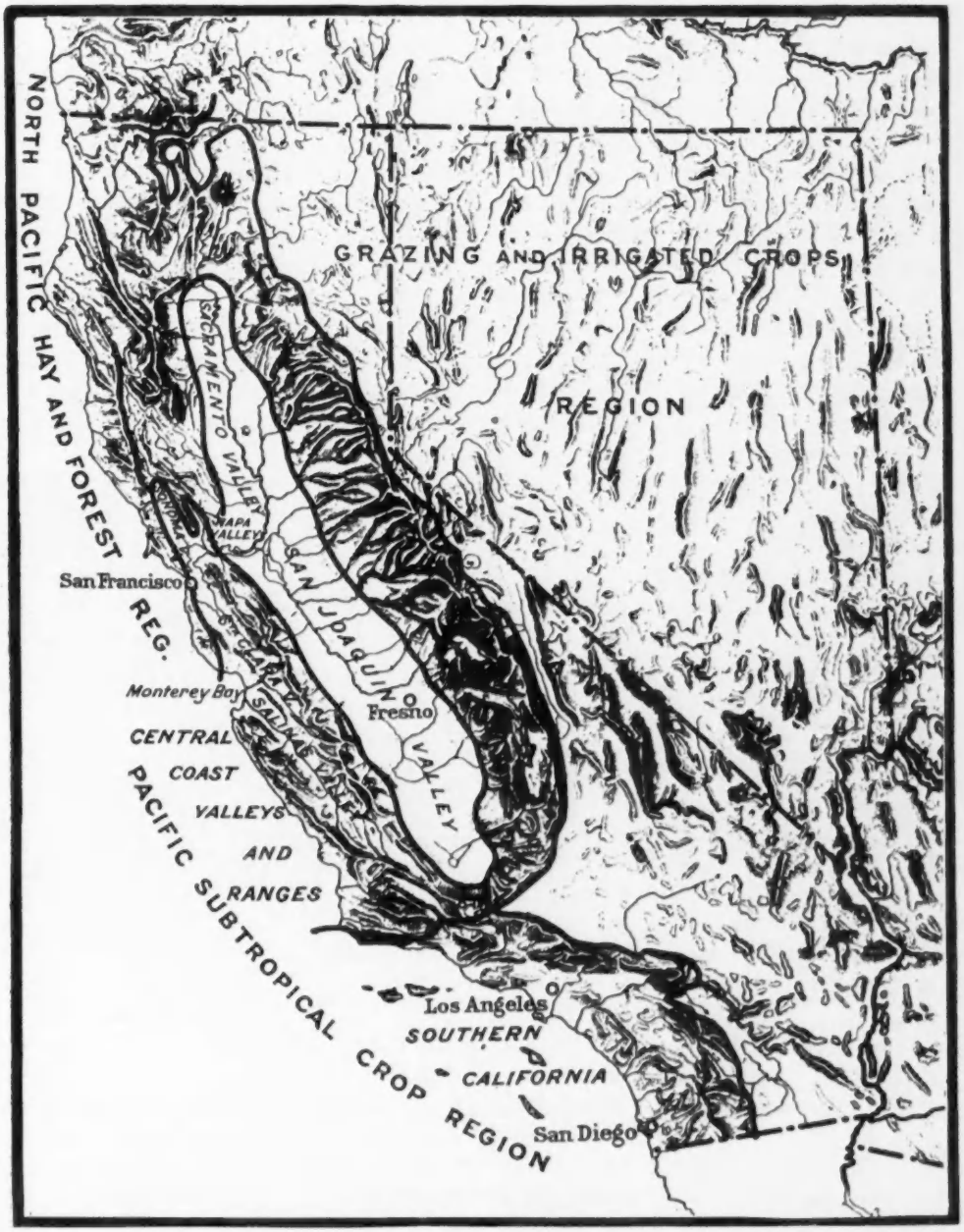


FIGURE 209.—The Pacific Subtropical Crops Region is confined to California, except for a small and mostly arid extension in the Lower California portion of Mexico. The region includes (1) the San Joaquin and Sacramento valleys, known jointly as the "Great Valley," (2) the valleys that drain into San Francisco Bay from the north and south, also the Coast ranges to the south of the Bay, the Salinas Valley, and the coastal plain and valleys from Santa Cruz to Point Conception, and (3) the coast, valleys and mountains of Southern California, but excluding the desert east of the mountains. The dominating influence of topography in determining the utilization of the land is further indicated by the fact that the mountains supply the water to irrigate the valleys and also exert a strong influence upon temperature conditions. The map is a photograph of a part of the hachure and drainage drawings for a base map of the United States prepared by F. J. Marschner for the *Atlas of American Agriculture*. The delicacy of the original drawing is obscured in the photograph.

includes also the Coastal Belt south of Santa Cruz. It is one of the smallest of the agricultural regions of North America, averaging about 125 miles wide, except that the northern and southern portions are narrower, and is 800 miles long (see Fig. 209). The total area of the United States portion is about 50,000,000 acres, but fully 10,000,000 of these are in the Coast Ranges, the San Gabriel, and other mountains. There are also about 5,000,000 acres in Mexico that have been classified with this region, but these lands are very dry, providing little else than desert range for cattle, and as no statistics are available concerning their agriculture, they will not be considered further.

FIGURE 210.—Palms are grown for ornament in nearly all the valleys of the Pacific Subtropical Crops Region, but are more common in Southern California. In this section of California many streets are lined with fan-leafed palms, like this street in Redlands. (Photo from Prof. H. P. Gould, U. S. Bur. of Plant Industry.)

Of the 40 million acres of land in the region, excluding the mountains and the desert, only 16 per cent was in crops, including orchards, in 1924, while practically all the remainder was used for pasture, including the one or two per cent of the land in woodland and the eight per cent in chaparral (semi-arid dwarf forest and brush). Despite this small proportion of the land in crops, the value of the crops per square mile of land area ($9,000 in 1919, the latest year for which complete figures are available) was greater than in any other agricultural region except the Corn Belt. Although crops occupy only one-fifth as great acreage as pasturage, their value is vastly greater than that of the pasturage.

The Subtropical Crops Region is one of the most populous regions in the West. In 1920 its population was about 3,200,000, which has increased, probably, to 4,000,000 today. Although the region covers only about one-third of the land area of California, it includes over 93 per cent of the people of the state. The two largest cities in the West, Los Angeles and San Francisco, are located in this region, and these, together with many smaller cities, provide a market not only for much of the produce of the region, but also

for some of the products from the Grazing and Irrigated Crops Region to the east.

Nevertheless, this Subtropical Crops Region ships out a larger proportion, probably, of its agricultural products than any other agricultural region in North America. Over 90 per cent of its oranges, lemons, grapes and raisins, prunes, peaches, figs, pears, and various vegetables, both fresh and canned, beans, cotton, and wool are sent to the Eastern or Northern States or to foreign countries. Only the milk and dairy products, the poultry and eggs, the meat, and the grain and hay are consumed mostly within the region.

The region produced crops in 1919 having a farm value of about $550,000,000, but owing to the fall in prices the value is probably somewhat less today, despite a notable increase in production. This value of the crops in 1919 was less than four per cent of the total value of crops in the United States, but these were grown on an acreage less than two per cent of the total in the nation. The average value of the crops per acre was nearly $100 in that year, as compared with $40 for the nation as a whole. About half of the value of all crops in the region consisted of fruits and nuts. Vegetables in 1919 totaled only one-tenth of the value of all crops, but the proportion is doubtless higher today. In no other region do fruits constitute so large a proportion of the value of all crops, and only in the Middle Atlantic Trucking Region are vegetables as important. The influence of the oceans, which moderate the winter temperatures, appears to be the dominant factor in determining the utilization of the lands in both these regions, but a contributory factor is the growth of large urban populations along these eastern and western coasts of the continent. The Pacific Region, in addition, has a bulwark at its back —the Sierra Nevada and San Bernardino Ranges, which shield the California Valleys from the low winter temperatures of the arid interior region.

In addition, to fruits and vegetables, hay, principally alfalfa and grain cut green, and the cereals, principally barley, are important, contributing jointly about one-third of the value of all crops. Indeed, the acreage of the hay crops is greater, and of grain crops is almost equal to the acreage in fruit. But, the value of the fruit crops per acre ranges from six to ten times that of the hay and grain crops. Sugar beets, beans, and cotton are also important crops locally.

PHYSICAL CONDITIONS

The northern end of the Subtropical Crops Region is 800 miles north of the southern end, yet the same crops are or can be grown throughout the region. Palms are grown for ornament nearly everywhere, and orange orchards are found on the foothills near the northern end of the region as well as in the southern portion (Figs. 210 and 228).

BOUNDARIES

The eastern boundary of the region is set by the Sierra Nevada Range, including the Tehachapi, and by the mountain ranges in Southern California. On the west also the region is bounded by mountains as far south as Monterey Bay. These mountains, like the Sierra Nevada, were more or less clothed with forest as far south as this bay. In general, the Subtropical Crops Region was

originally grassland, and the boundary line along the various mountain ranges has been drawn commonly where the grassland or open oak stands of the valleys give place to heavy chaparral or coniferous forest. This brushland or forest edge marks also in some places the edge of the valley bottom, in other places the upper edge of the rolling foothills. It commonly coincides with a sharp break in the topography (Fig. 211).

Included in the region are the Coast Ranges south and east of San Francisco and Monterey Bays. Some of these have a few coniferous trees on their summits, and along the immediate coast for several miles south of Monterey Bay redwood trees are found in moist coves. But, except for these few moister spots, the region is not forested. This distinguishes it from the North Pacific Hay and Pasture Region, which is forested, except in a few valleys. In addition, the Subtropical Crops Region has a milder, Mediterranean type of climate.

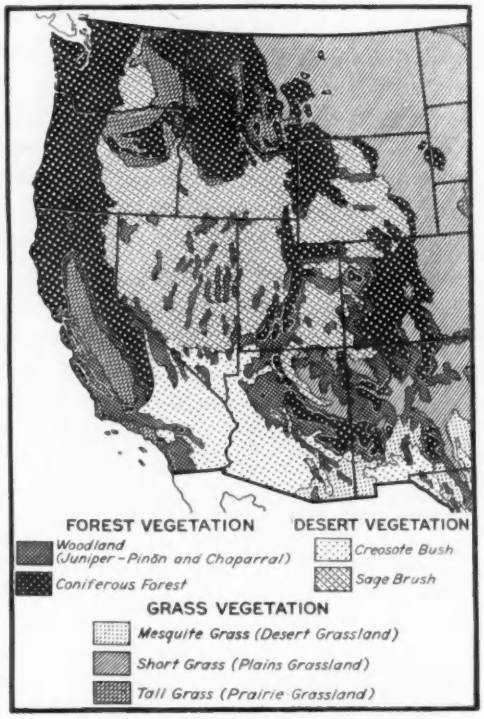


FIGURE 211.—The original vegetation in most of the valleys in the Subtropical Crops Region was probably California bluegrass and needle grass, but this has been modified by grazing to a final stage of red brome and other bunch-grasses, with which are mixed many flowering plants. On the adjoining hills is usually a belt of chaparral or live-oak, with coniferous forest on the higher mountains. (Map generalized from *Atlas of American Agriculture* map by Zon and Shantz, 1921 Yearbook, U. S. Dept. of Agr.)

CLIMATE

The region, as the name indicates, has a subtropical climate. Frost has been reported in every portion, but it is commonly not severe, the temperature in the foothills and bench lands seldom falling below 26 degrees, which is as low as citrus trees will stand for a few hours without injury under normal conditions of humidity. A frost that will kill tender garden vegetables, such as tomatoes, occurs nearly every year, except around the shores of San Francisco Bay and in parts of the lower Sacramento Valley, also along the coast south of San Luis Obispo, and on the foothills of the valley from Los Angeles east to Redlands and Riverside. However, it is seldom that frost occurs anywhere in the region after April 1 (except in the Delta district of the Sacramento and San Joaquin Rivers), nor before November 1. The average duration of the frost-free season is, therefore, over 240 days in nearly all portions of the region, except in the mountains, and in the low-lying "pockets" into which the cold air flows at night. In much of the region the frost-free season exceeds 270 days.

Because of this accumulation of cold air in the lower lands, the citrus trees, almonds, and other fruits sensitive to frost are commonly grown on

the alluvial fans or foothills, where the night temperatures normally are higher and the day temperatures lower and less stimulating to early bloom than in the valley bottoms. Even on these higher lands artificial heat is sometimes required, notably when "northers" blow in from high pressure areas to the north or northeast (Fig. 212). Even when not injuriously cold, these high winds occasionally do serious damage by stripping fruit from the trees. The bottom lands are used mostly for the hay and grain crops and for the hardier fruits and nuts, or else only for pasture.

Although the winters are almost free from freezing weather, the winter temperatures are cool and similar throughout the region, averaging about 50 degrees. On the other hand, the summer temperatures vary widely in the different districts. The coast is normally cool in summer, both night and day, the temperature ranging from 50 or 55 degrees in San Francisco at sunrise to 65 and occasionally 70 degrees in the afternoon, while at San Diego, near the Mexican Boundary, the sunrise temperatures are usually 60 to 65 degrees, and the afternoon maxima 70 to 75 degrees. In the Sacramento and San Joaquin valleys, on the other hand, the average summer temperature ranges from 50 or 60 degrees in the early morning to 90 or 100 degrees in mid-afternoon, except in the Delta district and inland as far as Sacramento, which are reached by ocean winds from San Francisco Bay. Likewise in Southern California, while Long Beach averages 79 degrees daily maximum temperature in July, Riverside, less than 50 miles inland, but behind a low range of mountains, averages 93 degrees. In nearly all the interior valleys of the Pacific Subtropical Crops Region temperatures exceeding 100 degrees occur frequently in the summer. Fortunately, the nights are cool, the minimum temperature normally falling below 70 degrees throughout the region, and the nearby coast is still cooler. As the roads are good, it is customary for many families living in the interior valleys "to Sunday" on the coast.

FIGURE 212.—No part of the Pacific Subtropical Crops Region is frost-free, and although certain sites are well adapted to citrus fruit, it has proven possible on other sites to reduce the injury to fruit by freezing, and avoid the much more serious injury to the trees, by using orchard heaters. These usually burn oil, and are placed as thickly as one to a tree where the orchard is a very valuable one. Thermostats located in the orchard are set to ring a bell in the farmer's house when a temperature of 28 or 30 degrees is reached, and then all the family and any others that can be employed rush through the orchard lighting the fires. The object is to keep the temperature above 28 degrees until the sun rises and never let it go below 26 degrees, as this degree of cold will injure the fruit. (Photo by Los Angeles Chamber of Commerce.)

The rainfall régime of the region is also both characteristic and variable. The first rain after the summer drought usually occurs in October, sometimes a couple of weeks earlier in the northern than in the southern portion of the region. The rainfall increases during November, when an inch or more of water is likely to be received, and reaches a maximum of 3 to 6 inches in January or February.

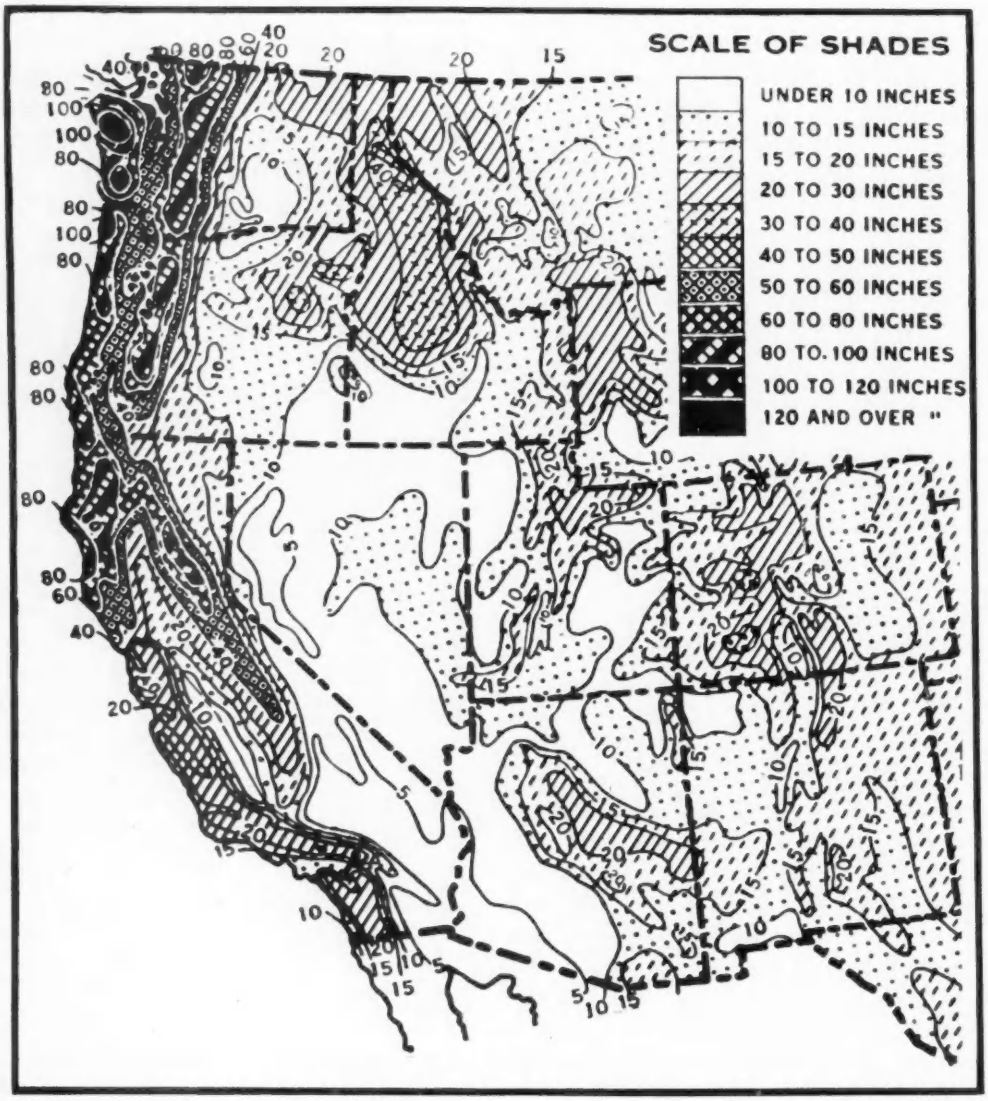


FIGURE 213.—Average annual precipitation. The yearly rainfall in the Subtropical Crops Region is mostly between 10 and 30 inches. Much of the west side of the San Joaquin Valley and a little of the coast near San Diego have less than 10 inches, on the average; while in the extreme upper Sacramento Valley and on the higher mountains in Southern California the rainfall is 30 inches and even more. Practically all of the agricultural area receives between 10 and 25 inches of rain in the normal season. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

The rains then normally become less frequent until April or May, varying with the locality, after which no rain may be expected, except in the mountains, until October. But, along the immediate coast heavy fogs often occur even during the summer, and these appear to provide a little moisture for the crops, notably the bean crop in Ventura and Orange counties. The fogs also raise greatly the relative humidity and reduce evaporation.

The average annual rainfall in the region is, of course, much heavier in the mountains than in the valleys,

and is also heavier in the Sacramento Valley than in the San Joaquin (Fig. 213). It is somewhat heavier also along the eastern side of the Great Valley beneath the Sierra Nevada than along the western side of the valley in the "rain shadow" of the Coast Ranges. In most of the San Joaquin Valley the annual rainfall averages less than 15 inches, and in much of the valley is less than 10 inches. In the Sacramento Valley it increases from 15 inches at the southern end, where it adjoins the San Joaquin, to 30 and even 40 inches locally at the extreme northern end. In the San Francisco Bay district the annual rainfall ranges from 15 to 30 inches, and is even heavier in the upper Sonoma Valley. The Salinas Valley and Monterey Bay districts average about 20 inches of rain annually; while in the Los Angeles area, extending eastward to San Bernardino and Banning, the rainfall ranges mostly from 10 to 20 inches. Along the coast at San Diego it falls below 10 inches. In the mountains a few miles east the rainfall exceeds 25 inches, and on Mounts San Jacinto, Grayback, San Bernardino, and San Antonio ("Old Baldy") there is reported to be from 10 to 20 feet or more of snow in the normal winter, while showers occasionally occur even in mid-summer (as the writer knows by unpleasant experience).

These heavy snows in the mountains provide water for irrigation in the valleys the following summer, and in seasons when the snows are light the water may be short the following summer. Nowhere has there been more skillful development of water by wells in the alluvial fans and "washes" at the base of the mountains, and by the construction of subterranean dams in the gravelly stream courses, as well as by reservoirs in the mountains. And nowhere is irrigation water conserved more carefully. In Southern California nearly all the water is conveyed by covered concrete pipes or conduits to reduce evaporation, and open canals with earthen walls, such as are common in most western states, are almost unknown. The water is too valuable to lose by seepage. In the Great Valley, where water is less valuable, canals are common.

However, not all the crops, even in Southern California, are irrigated. Most of the cereal crops in the Pacific Subtropical Crops Region are grown in the winter months and depend on the natural rainfall. The almond orchards, and about half of the walnut, grape, and fig acreage, according to the census, are commonly not irrigated. Only 40 to 50 per cent of the prunes, pears, cherries, and apricots, and about 25 per cent of the apple acreage are irrigated. In general, from one-third to two-thirds of the acreage in the various vegetables is irrigated. On the other hand, most of the alfalfa, nearly all of the cotton, and all of the citrus fruit and rice are irrigated. The total irrigated area in the region in 1919 (the last year for which data are available) was about 3,500,000 acres, which was about 60 per cent of the acreage in crops (Fig. 214). Owing to the decrease in acreage of dry-land crops between 1919 and 1924, indicated by the census, and a probable slight increase in irrigated area, it is likely that today about two-thirds of the crop acreage of the region is irrigated.

It is evident, therefore, that the agriculture, particularly the horticulture, of the Pacific Subtropical Crops Region is based largely on the

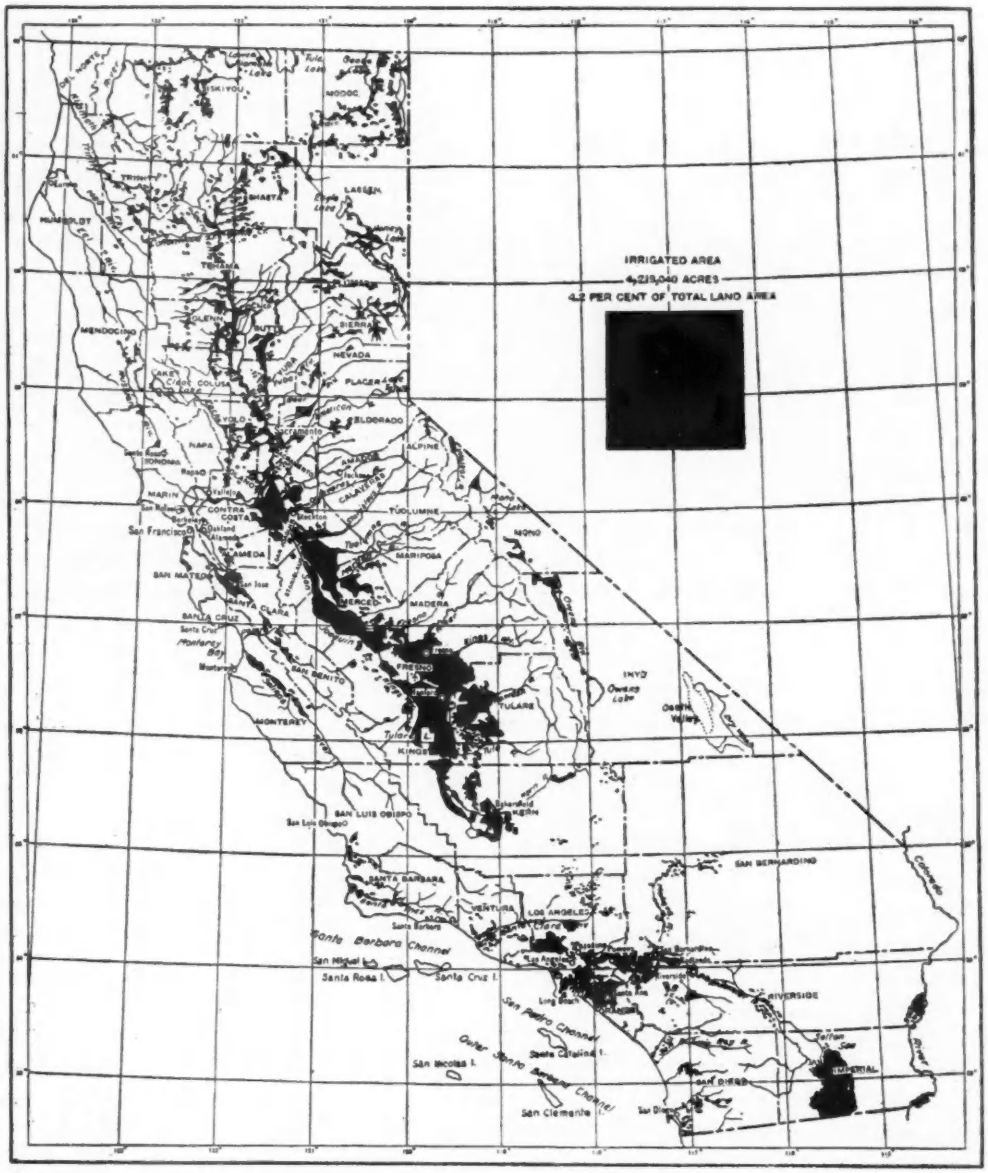


FIGURE 214.—Approximate location and extent of irrigated land in California. There were about 3,500,000 acres of irrigated land in the Pacific Subtropical Crops Region in 1919, of which 77 per cent was in the Great Valley, 18 per cent in Southern California, and 5 per cent in the Central Coast Valleys, principally the Santa Clara and Salinas. It will be noted that the San Joaquin Valley contains much more irrigated land (2,000,000 acres) than the Sacramento (640,000 acres), where the rainfall is heavier and a large proportion of the crops are grown without irrigation. (Map reproduced from Vol. VII of the Fourteenth Census, "Irrigation and Drainage," prepared largely by Ray P. Teele.)

extensive use of irrigation. Nowhere else in the United States has so much money been spent in overcoming the climatic conditions. But, it should be recalled that this money has been spent largely in an effort to take advantage of the favorable temperature conditions for the production of subtropical crops, grapes, and early vegetables. Here, as elsewhere,

man's so-called conquest of nature consists essentially in modifying the disadvantage of one physical factor in order to take advantage of another factor, this modification being accomplished usually by the application of power in one form or another. In the case of irrigation this modification of the natural condition is being achieved at increasing cost per acre as the more feasible projects are developed. The physical conditions in a region are like a spring which yields under pressure, but as the pressure is increased, the resistance becomes proportionally greater, until eventually the point is reached at which increased pressure becomes unprofitable. This point appears to have been reached with reference to irrigation in most parts of the West. Indeed, the agriculture of the United States as a whole is now at that stage where it is generally more profitable to increase the yield per acre than to increase the acreage. The climate is still unmodified by man on 90 per cent of the land of the Pacific Subtropical Crops Region. But, the 10 per cent of the land which the Californians have reclaimed from aridity is a great tribute to their skill and perseverence. In no other part of the world has there been a greater conquest, and it is fitting that they should be proud of it.

TOPOGRAPHY

The agricultural portion of the Pacific Subtropical Crops Region consists mostly of the valley bottoms and adjacent piedmont slopes, in general below 1,000 feet elevation. However, in the pass near Banning, about 100 miles east of Los Angeles, there is a considerable acreage of deciduous fruit, including apples, at an elevation of 2,600 feet, and in the San Bernardino mountains there are apple trees at over 4,000 feet altitude. With few exceptions, however, the mountains in the region are covered with oak brush or forest, whose principal function is to conserve the water supply, and in places also to provide pasture. Four of the mountain peaks, all located in Southern California, exceed 10,000 feet in altitude. In the Coast Ranges there are only a few points above 4,000 feet elevation.

The mountain ranges divide the region into three parts: (1) the interior Sacramento-San Joaquin, or Great Valley, (2) the coastal valleys and coast as far south as Point Conception, and (3) the Southern California valleys and coast (Fig. 209).

The Great Valley is a structural trough between the Sierra Nevada on the east and the Coast Ranges on the west, enclosed at the north end by the Klamath Mountains and at the south end by the Tehachapi, and filled with rock-waste and sediments mostly from the Sierra Nevada. It is over 400 miles long and 40 to 50 miles in width, with an opening a little north of the center through the Coast Range to San Francisco Bay. The lands near this opening are marshy, and through the branching channels of the Sacramento-San Joaquin Rivers, boats from San Francisco navigate as far inland as Stockton and Sacramento. The floor of the Great Valley in general is a series of coalescing alluvial fans radiating from the mouths of mountain cañons, together with sediments deposited where the drainage has been obstructed. Such a fan-like rise of land about midway of the San Joaquin Valley diverts the drainage in the southern portion of the valley into Tulare and Buena Vista lakes, which

are very shallow and are gradually drying up. The area of the Sacramento Valley is about 4,000,000 acres, of the San Joaquin nearly 8,000,000 acres, a total of nearly 12,000,000 acres in the Great Valley. Much of this land is tillable without irrigation and nearly all of it would be tillable if irrigated or drained. But, for permanent cultivation most of it will need to be both irrigated and drained.

The Central Coast and Valleys subregion includes (1) the valleys that drain into San Francisco Bay (excluding the Great Valley), principally the Sonoma and Napa on the north and the Santa Clara on the south, (2) the Monterey Bay coast and Salinas Valley, and (3) the San Luis Obispo-Lompoc district. The San Francisco Bay valleys and the Salinas Valley are structural troughs like the Great Valley, but much smaller. The San Francisco Bay valleys have a total area of possibly 1,000,000 acres, and there may be another million acres of valley land in the Salinas and other valleys north of Point Conception and along the coast, the surface of which is suitable for crops. It is barely possible that there are 2,000,000 more acres of rolling land in the foothills topographically available for crop production.[1] It seems very unlikely that there are more than 4,000,000 acres of tillable land in all this subregion.

The Southern California sub-region consists principally of a narrow coastal plain and of the valley that extends eastward from Los Angeles to Redlands, including the San Fernando Valley and the Riverside and San Jacinto districts. The Los Angeles-Redlands Valley is another structural trough, and it is on the alluvial fans fringing this valley that most of the oranges and lemons are grown. Including the Riverside district and the San Fernando Valley, it may be roughly estimated to contain 1,200,000 acres of potentially arable land, to which should be added possibly 300,000 acres for the San Jacinto-Elsinore district. There may be another million acres of topographically tillable land along the coast, principally in Orange, Los Angeles, and Ventura Counties, and another half million acres in the valleys of San Diego County. The total area of potentially tillable land in this subregion, including that now tilled, appears likely, therefore, to be about 3,000,000 acres.

In all the Pacific Subtropical Crops Region there is, apparently, only about 19,000,000 acres of topographically tillable land, nearly two-thirds of which is in the Great Valley. In other words, possibly one-third of the entire area of the region is tillable were water available, nearly one-half is upland too dry or else too steeply rolling for crop production, and one-sixth or more is mountainous. Of the 19,000,000 acres tillable less than 7,000,000 acres are at present under cultivation, or about one-third as much as in Illinois or in Iowa. The value of the crops, however, is probably as great as in either of these states.

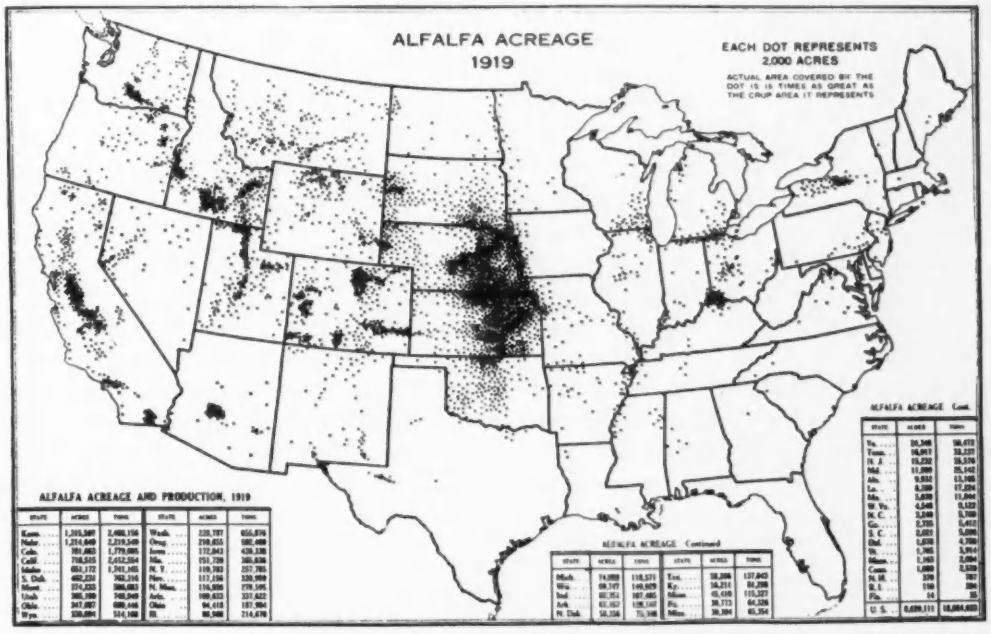
SOILS

The soils in the Pacific Subtropical Crops Region are classified by the Soil Survey into (1) residual soils, or those derived from the weathering of consolidated rocks in place; (2) old valley-filling soils, which are derived

[1] Estimate based on "Reconnaissance Soil Survey of the San Francisco Bay Region," by L. C. Holmes and J. W. Nelson. Washington, 1917.

from old weathered and otherwise modified unconsolidated, water-laid deposits; (3) recent alluvial-fan soils, which are derived from stream deposits that have undergone little, if any, change by weathering since they were laid down; (4) lake-laid soils; (5) wind-laid soils, or those owing their accumulation to wind action; and (6) miscellaneous soils, mostly rough broken land, tidal marsh, coastal beach, dune sand, and river wash.

"The residual soils predominate in the hilly and mountainous regions; the old valley-filling soils prevail along the valley margins in the form of extensive fans and foot slopes, or elevated stream or marine terraces; and the recent alluvial soils form the lower parts of the valley floors or lie on the valley slopes influenced by recent stream deposits."[2] The lake-laid soils are confined to the flat shallow basin of Tulare and other lakes, and the wind-laid soils, which are not very extensive, are developed principally near the ocean beaches and in the drier parts of the region. Most of the valley soils belong to the old valley-filling and recent alluvial groups. The miscellaneous group of soils are practically all non-agricultural.


ALFALFA ACREAGE
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ALFALFA ACREAGE AND PRODUCTION, 1919
ALFALFA ACREAGE Continued
ALFALFA ACREAGE Concl.

FIGURE 215.—Most of the alfalfa in the Pacific Subtropical Crops Region is grown in the Great Valley, principally in the San Joaquin portion. In this valley both water for irrigation and land are more abundant and cheaper than in Southern California or in the valleys north and south of San Francisco Bay, which are given over largely to orchards—a more intensive use. There is, however, a considerable acreage of alfalfa in these valleys, grown mostly where irrigation water is readily available. About 1,000,000 acres are in alfalfa in the entire Subtropical Crops Region, producing normally 4,000,000 tons of hay. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

"The groups named are characterized by essential differences in character of soil and sub-soil material,

[2] J. W. Nelson and others: "Reconnaissance Soil Survey of the Upper San Joaquin Valley, California, Field Operations of the U. S. Bureau of Soils, 1917." Washington, 1921.

topographic positions, age, chemical properties, and mode of formation. They are subdivided into groups called 'soil series,' each of which includes soils having certain common characteristics, such as color, character of sub-soil, origin, and other features, distinguishing it from other series in the same province. The types, or members of the series, are separated on the basis of texture, or the relative amount of sand, silt, and clay present.

"The residual soils . . . usually occur in hilly and mountainous positions. They are typically well drained. These soils vary greatly in depth, but the parent rock is usually encountered at less than 6 feet. . . . They contain varying amounts of rock out-crop, and are eroded or deeply furrowed in some places. The underlying rocks vary greatly in composition, origin, and topographic position. They are sedimentary, igneous, or metamorphic in character. Those of sedimentary origin are principally calcareous shales and sandstones with lesser amounts of conglomerate.[3]

"Soils derived from the old valley-filling or coastal-plain deposits are extensively developed in the region. They consist of elevated, unconsolidated, water-laid deposits which have undergone marked changes in soil and subsoil features since they were laid down. . . . They vary widely in color and mineral composition. Their heavy, compact soils and substrata are among the most important features which serve to distinguish them from soils of the other provinces. Some of the series in this group are marked by calcareous subsoils, others by gravelly substrata, and some by the presence of an indurated hardpan. . . . Their less well-aërated and permeable subsoils often make them less desirable for tree-fruits. The soils of this group along the ocean are characterized by their terraced position and frequently by an escarpment of 20 to 100 feet or more along the water front.

"The soils of recent alluvial origin are still in process of accumulation. They are very extensive in the valleys, and include the lightest colored and lightest textured soils. They have a smooth, uniform surface and permeable subsoils, in contrast to the higher and more uneven surfaced old valley-filling soils, with their heavy, compact, and poorly aërated subsoils." . . . In general "these are the most intensively developed soils of the region, and have a higher average value than any other group. Underground water for irrigation is available" in many places by pumping, especially "where these soils occur on the valley floor or along stream bottoms, but owing to the position and elevation of the more steeply sloping alluvial fans these areas have only a very scant water supply, which must be increased from outside sources if fruit and truck crops are to be grown under the most intensive management." A high water table sometimes is found in low-lying areas, and injurious amounts of alkali have occasionally accumulated locally.

"The soils of wind-laid origin are quite extensively developed" in several parts of the region. . . . "They have a ridged, undulating, or hilly topography and in some areas have been formed almost entirely by material drifted inland from the sandy

[3] "Soil Survey of the Los Angeles Area," by J. W. Nelson, C. J. Zinn, and others. Washington, 1919, pp. 22–23. In other areas the shales are not principally calcareous and various other sedimentary rocks are found.

ocean beaches. The soils are quite uniform, but usually become somewhat finer in texture with increased distance from the ocean. Drainage is good to excessive."[4]

Space does not permit a description of the soil series, nor to mention the soil types, but it should be noted that there are hundreds of different soils in the region and that these vary widely in their characteristics and their fertility. Although many of the soils, especially some of the recent alluvial and residual soils, are high in the mineral elements of fertility, owing to their youth and to the arid and sub-humid climate, they also tend to be very porous, while the older alluvial soils tend, on the contrary, to have either hardpan or relatively impermeable clay subsoils.

Nowhere else probably, except in Florida and the Atlantic Coastal Plain, are such poor soils used for crop production, and nowhere else has such careful study been given in fitting the crop to the soil. Recently much attention has been devoted also to problems of fertilization.

Agriculture in California is based on science and deduction from experience to a greater degree, perhaps, than in any other part of the nation. When one considers the difficulties of moisture and temperature, topography and soil that have been overcome, and the location of the region two to three thousand miles from its major markets, then views the evidence on every hand of the accumulation of a wealth and culture which is not surpassed elsewhere in the world, and realizes that this civilization has been erected within the brief span of 75 years, it seems fitting to pay this feeble tribute to the intelligence and perseverence of the people of this state.

[4] "Soil Survey of the Los Angeles Area," by J. W. Nelson, C. J. Zinn, and others. Washington, 1919, pp. 24–29.

LAND UTILIZATION

Eighty years ago, when California became a part of the United States, the region was almost wholly a cattle-ranching country, and even today apparently 60 per cent of the land is primarily devoted to grazing. But, from the standpoint of value of products, California is now primarily a crop production region—the outstanding fruit and vegetable growing region of North America. It appears probable that crops constitute nearly 90 per cent of the total value of agricultural production in the region, and that fruits and vegetables contribute fully half of this value.

The development of agriculture in California illustrates in striking manner many of the features that have characterized the trend of agricultural development in the United States as a whole. Two features in this trend stand out prominently: (1) Increasing production per acre and (2) increasing efficiency of labor.

INCREASING PRODUCTION PER ACRE

Crop acreage in California increased for many years, but between 1919 and 1924 decreased according to the Census.[5] In 1879 there were about 3,300,000 acres of crops harvested (including an estimated figure for acreage of fruit trees based on the number of trees), in 1889 the acreage had increased to nearly 5,400,000, and by 1899 it had risen to 7,000,000

[5] In order to avoid laborious statistical tabulations by counties, the changes since 1880 (when the Census first enumerated acreage) in land utilization in California as a whole will be considered. As the Subtropical Crops Region includes about 94 per cent of the crop land of the state, any error resulting is unlikely to be serious.

acres. But, in 1909 it had fallen to 5,700,000 acres, or nearly to the 1889 level, and after a recovery to almost 6,900,000 acres in 1919, the crop area harvested in 1924 was again only about 5,700,000 acres. The decrease in total crop acreage harvested in the United States between 1919 and 1924 was about 4 per cent, whereas in California it was nearly about 18 per cent. However, 1924 was a very dry year in California and there were nearly 1,700,000 acres of plow land lay idle or fallow in California. As the acreage of summer fallow in the State is not large, it appears that most of this land lay idle. A similar condition exists in many parts of the United States. If only the crop acreage were considered, the conclusion would be clear that agriculture in California was declining. Instead, production has greatly increased, as will be shown later.

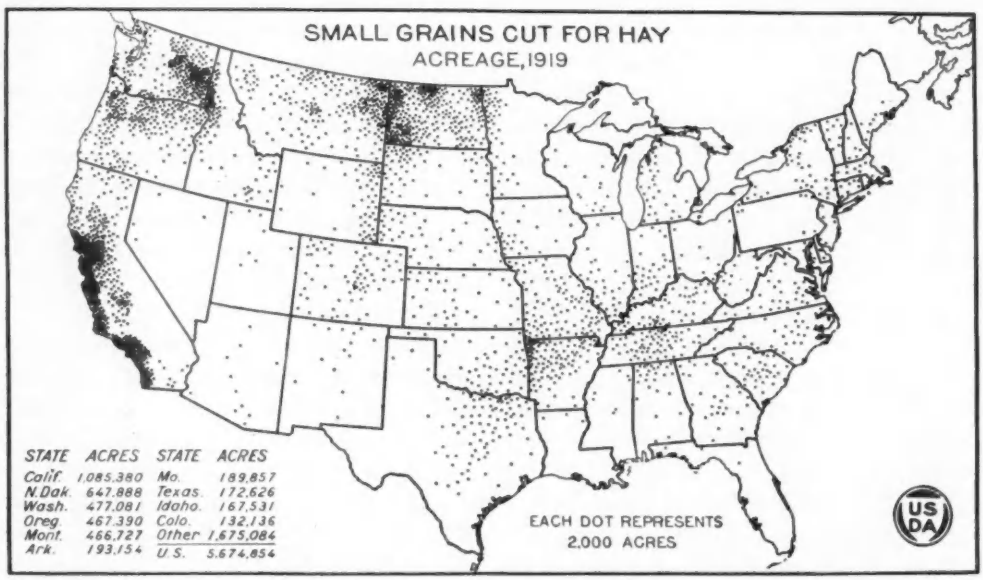


FIGURE 216.—Most of the grain hay in the region, unlike alfalfa, is grown in the Central Coast Valleys and in Southern California. There is sufficient rainfall during the winter in most of these subregions to produce a crop of hay without irrigation, and the small grains endure the frosts of winter without serious injury. The grain is cut in the spring while in the milk stage and makes a nutritious hay. Barley is the principal grain cut for hay, but wheat, oats, and rye are also used. The area of grain hay in the region averages now only about 600,000 acres, and the production 800,000 tons. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

nearly a million acres of crop failure reported. The acreage of crop failure in 1919 is unknown, but was undoubtedly much less than in 1924.[6]

In 1924, according to the Census,

[6] The estimates of the California Coöperative Crop Reporting Service indicate an increase in total crop area of over 1,100,000 acres between 1924 and 1928. But, the value of the 1928 crops was only a little more than that of 1924. In 1929 production has been much less, but the sale value of the crops will be much greater than in 1928.

Concentration of Capital and Labor on the Better Land

The figures of irrigated area show a very different trend—1,000,000 acres in 1890, 1,400,000 acres in 1900, nearly 2,700,000 acres in 1910, and 4,200,000 acres in 1920. Whereas total crop acreage decreased slightly between 1900 and 1920, irrigated acreage increased nearly 200 per

cent. In 1899 only 20 per cent of the crop acreage was irrigated, in 1919 about 60 per cent. As previously noted, probably two-thirds of the crop acreage is irrigated today. Complete data are not available since 1920. As the irrigated land is, in general, more level or more fertile than non-irrigated, it is clear that capital is being concentrated on the more productive land.

Labor also is being concentrated on the better land. Each successive census has shown an increase in the number of farms or farmers. The number doubled between 1880 and 1900, and almost doubled again between 1900 and 1925. The quantity of hired labor employed on farms (as estimated by the expenditure for labor divided by the average wage) likewise has increased. It almost doubled from 1899 to 1909, but increased, apparently, only about 10 per cent between 1909 and 1919, and about 25 per cent between 1919 and 1924.

Obviously the decrease in crop acreage and increase in number of farms has resulted in a decreased acreage of crops per farm. In 1889 the average farm in California had about 96 acres of harvested crops, in 1909 only 65 acres, and in 1924 about 42 acres.

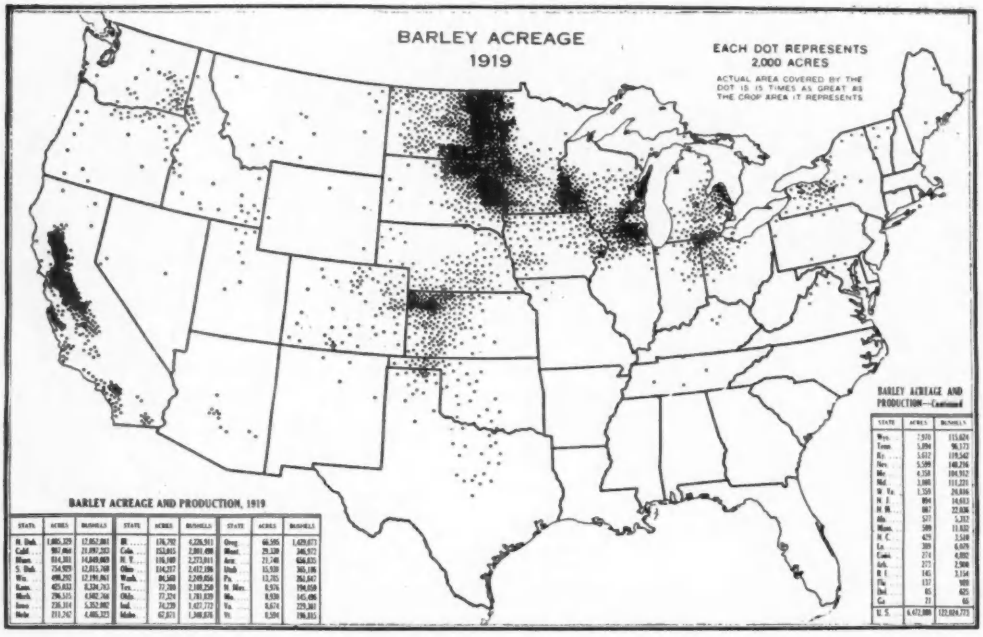
Shifts in Systems of Farming

This concentration of labor and capital on a smaller acreage has involved a shift in the system of farming—from wheat, barley, and beef production to fruit and vegetables, dairying and poultry. The area in wheat has fallen from nearly 2,700,000 acres in 1899 to only 360,000 acres in 1924, barley from 1,200,000 acres in 1909 to 750,000 in 1924, hay from 2,500,000 acres in 1909 to about 1,800,000 in 1924. However, the proportion of this hay acreage which is alfalfa has increased from less than one-fifth to over two-fifths in the fifteen years, and the nutritive value of the total hay production today is probably as high as ever before.

Changes in Production of Animal Products

Despite this contraction in acreage of barley and hay, the production of animal products in California is apparently greater than ever before. Doubtless this is owing in part to the increasing acreage of alfalfa. Between 1919 and 1924 the number of milk cows increased 11 per cent and the production of milk 23 per cent, according to the Census. This is a considerably greater gain, probably, than the increase of population in the State. Between 1919 and 1924 the average annual production of milk per cow increased nearly 65 gallons, or about 12 per cent. It is probable that the increase in production of milk per unit of feed consumed has been one-third to one-half as great as this increase in production of milk per cow.

The number of beef cattle has declined slightly since the war period, and of hogs notably, but the change in production of beef and pork is not known. On the other hand, there has been a great increase in the number of sheep. From 1900 to 1922 the number of sheep in the state remained more or less constant, but from 1922 to 1928, the number increased over 40 per cent. The number of chickens on farms January 1 increased nearly 23 per cent between 1920 and 1925, while the number of eggs produced increased 53 per cent according to the Census returns. The increase in production of eggs


BARLEY ACREAGE
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ACTUAL AREA COVERED BY THE DOT IS 15 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS
BARLEY ACREAGE AND PRODUCTION, 1919
BARLEY ACREAGE AND PRODUCTION—Continued

FIGURE 217.—Barley is produced principally in the Great Valley. It is used locally for feed and also exported through San Francisco to England for malting. In the Salinas Valley the acreage also is large, relative to arable area. Most of the crop is unirrigated. It is planted in October and November, after the first rain, and harvested in April or May. There are usually about 1,000,000 acres of barley harvested for grain in the region and the production is about 30,000,000 bushels. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

during these five years was far greater than in any preceding ten years.

Dairying, sheep, and poultry production are the animal enterprises that have increased notably in California since the World War, whereas not only have the number of beef cattle and hogs decreased, but also the number of horses and mules has declined notably. However, there has been a marked recovery in the number of hogs during the past two years. The trends in these livestock enterprises are of interest in view of the need of finding alternative enterprises to the production of fruits and vegetables, for which it is becoming increasingly difficult to obtain markets. It may be added that the only animal products which are shipped out of the state to a material extent are wool, lamb, and eggs.

Increase in Fruits and Vegetables

While the acreage in grain and hay crops has decreased and the production of meat has increased only slightly, both the acreage and production of the fruits and vegetables have increased notably. The census figures on the number of fruit trees are comparable only as far back as 1909, when all the fruit orchards and vineyards occupied about 800,000 acres. Ten years later, in 1919, the area had increased to about 1,000,000 acres, or 25 per cent. Five years later, in 1924, the fruit area had increased to about 1,400,000 acres, or 40 per cent. Whereas from 1909 to 1919 the increase in fruit acreage was about 2.5 per cent a year, or a half more rapid than the increase in the nation's population, from 1919 to

1924 the rate of increase was about 8 per cent a year, or five times as rapid as the increase in the nation's population. By 1928 the estimates of the State Statistician indicated that the fruit area had increased to about 1,700,000 acres—a gain almost as rapid as in the five years preceding.

The increase in production prior to the war was about the same as the increase in acreage, but since the war it has been smaller. Combining the production of the nine most important fruits and nuts on the basis of the average farm price during the decade 1917–1926, it appears that the aggregate increase in production was about 24 per cent between the five-year period 1907–1911 (centered on the census year 1909), and the five-year period 1917–1921. But, between the period 1917–1921 and the period 1922–1926, production increased about 28 per cent. This smaller increase since the war in production than in acreage is probably owing principally to a larger number of young trees and vines in recent years than previously, and it may be owing in part to planting trees and vines on poorer soil.

The increase in acreage and production of vegetables grown for sale has been even more rapid. From 1899 to 1919 the increase in area, according to the Census, was from 28,000 to 146,000 acres, or five-fold in the twenty years. From 1919 to 1924, the area increased from 146,000 to about 234,000 acres, or 60 per cent. Even in this latter period the rate of increase in acreage of vegetables was about as large as that in the fruits, or seven times as great as the increase in the nation's population. In 1929 the area in vegetables was 401,000 acres, according to the estimates of the State Statistician, an increase of over 70 per cent in the five years.

Agriculture and Land Values

The total agricultural production of California at the present time is about three times that at the beginning of the century, when the acreage of harvested crops was greater than now. In other words, production per acre has increased three-fold. This has been accomplished principally (1) by shifts from less productive to more productive crops per acre, notably from grain crops to fruits and vegetables, and from grain hay toward alfalfa, and (2) by shifts from less productive to the more productive classes of farm animals per unit of feed consumed, notably from beef cattle to dairy cattle and poultry.

As a consequence of these shifts from the less productive to the more productive crops and farm animals, there has occurred an enormous increase in the value of land per acre. Wheat land is worth today perhaps $50 per acre, orchards $500 or more; grazing land for beef cattle is worth, perhaps, $25 an acre or less, hay land for dairy cows $100 an acre or more. California cannot go back to the more extensive systems of farming without experiencing a devastating decline in land values. A great decline in land values would mean an increasing rate of taxation, a tightening of credit, doubtless the failure of banks and business depression.

Nearly one-third of the crop land of California, a higher proportion than in any other state, is devoted to fruits and vegetables. These are the most intensive of all crop enterprises, and if California is to avoid serious economic consequences it cannot decrease this acreage very much. The solution of California's agricul-

tural problems apparently must be found elsewhere, and, apparently is being found in the development of improved varieties of fruits and vegetables, the introduction of new crops, such as cotton in the San Joaquin Valley, by finding larger markets both at home and abroad, and in other ways.

CHANGES IN THE EFFICIENCY OF LABOR

Decreasing the cost of production is a remedy commonly recommended as a partial solution of the agricultural problem in California, as well as in other sections of the United States. One of the largest costs in agricultural production is the labor cost. In the United States comparison of the aggregate agricultural production (excluding crops fed to livestock) during the five-year period 1917–1921 with that in the period 1922–1926 indicates an increase of about 14 per cent. The months of hired labor employed in agriculture (expenditure for labor divided by average monthly wage, by states) decreased 2 per cent between 1919 and 1924, while farm population decreased 6 per cent. Taking 4 per cent as the approximate decrease in months of hired labor, and recalling that the number of farmers remained practically stationary, there is indicated a decrease in total labor applied to agriculture of about 2 per cent; and, consequently, an increase in production per month of labor employed of about 16 per cent.

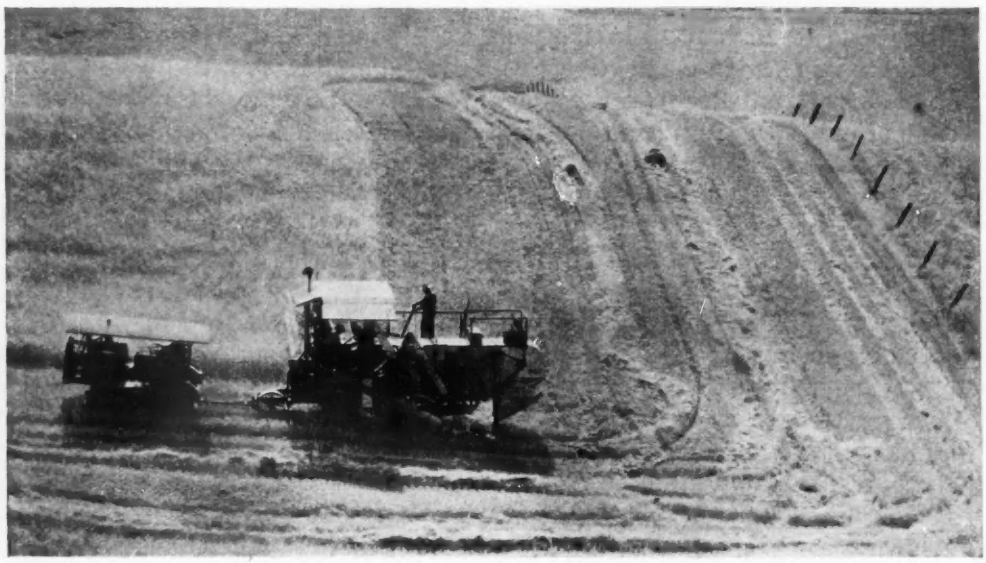

FIGURE 218.—In the earlier days the valleys of California, especially the Great Valley, were largely devoted to "bonanza" grain farming, and even yet many large farms remain. The picture shows a caterpillar tractor and combine-harvester cutting and threshing oats on one of the large farms. In the earlier days combine-harvesters were used, but were drawn by a steam engine, or sometimes by as many as 50 horses. (Photo from Los Angeles Chamber of Commerce.)

In California, preliminary estimates of agricultural production in the two periods 1917–1921 and 1922–1926 (each centered on the census year), which are deficient because of failure to include meat produced, and also because figures for milk and poultry products are available only

for the census years, but which are, nevertheless, probably roughly comparable, indicate an increase of about 25 per cent in production between these periods five years apart. Between the central years of these periods the number of farms, or farmers, increased 16 per cent and expenditure for labor divided by average wage increased 25 per cent. It appears that agricultural production in California per unit of labor applied increased somewhat between these two census years, probably about 5 per cent. Between 1909 and 1919, agricultural production in California per unit of labor employed increased much more, probably about 30 per cent. More complete calculation may alter these figures, but it seems unlikely that they could alter the general conclusion that owing to development of new orchards and vineyards, and doubtless to many other factors also, including the drought in 1923–1924, agricultural production per unit of labor applied has not increased since the war as rapidly as in the decade before the war. The contrast of the estimated 5 per cent estimated increase in California for the five-year period with the 16 per cent increase for the United States as a whole is striking.

While the figures indicate a smaller increase in agricultural production per unit of labor since the World War than in the previous decade, the increase in production per farm has been at about the same rate as in the years prior to the war. This average production per farm increased about 13 per cent between 1899 and 1909, and 17 per cent between 1909 and 1919, while the increase between the period 1917–1921 and the period 1922–1926 was about 9 per cent.[7] This is nearly 2 per cent a year, or at fully as rapid rate as in the preceding decades. Viewing the quarter century as a whole, it is interesting to note that agricultural production per farm increased over 40 per cent, despite a decrease in area of crops harvested per farm from 96 acres in 1899 to 42 acres in 1924 (49 acres if crop failure be included).

The increase in agricultural production per unit of labor applied since the World War probably would have been smaller than it has been had not the tractor been rapidly introduced. On January 1, 1920, there were 12,131 tractors on California farms, and on January 1, 1925, there were nearly 30,000.[8] This was a more rapid increase than in the United States as a whole; and the ratio of tractors to work horses and mules was higher in 1925 in California than in any other State—one tractor to fewer than 12 horses. In the Corn Belt States there was only one tractor to 25 horses in Illinois; 31 horses in Iowa; and 77 horses in Missouri. Measuring the importance of the tractor by the percentage of farms that have tractors, California also ranks near the top. On January 1, 1925, one farm in five in California had a tractor. Only the Dakotas exceeded California in this proportion of farms having tractors. This is the more surprising in view of the fact that the average area of crops harvested per farm in 1924 was 262 acres in North Dakota, 198 acres in South Dakota, and only 42 acres in California.

The percentage of the farmers in

[7] Sufficient data are not available to permit compilation of production by five-year periods prior to 1917.

[8] Although no data are available since 1925, rough estimates indicate that there are about 50,000 tractors on farms in California today (1929).

FIGURE 219.—Rice is a relatively new crop in California, extensive production dating from about 1909. It is grown almost wholly in the Sacramento Valley, where the rainfall is heavier and water from the mountains more abundant. After seeding on moist and carefully prepared ground, water is added as the plant grows until the field is covered about six inches deep. This depth is maintained until near harvest time, when the water is drained off, the ground allowed to dry and become sufficiently solid to carry a tractor and combine. (Picture taken near Biggs, in the Sacramento Valley, by C. E. Chambliss, U. S. Bur. of Plant Industry.)

California having automobiles is much greater. In 1920, the latest year for which data are available, 53 per cent had automobiles, a percentage that was exceeded only in the Western Corn Belt States and the Dakotas.

As a consequence of this widespread use of the tractor and automobile, a notable decrease has occurred in the number of horses and mules, as already noted. Between January 1, 1920, and 1928, the number decreased from 455,000 to about 343,000, or 25 per cent. If it required three acres of crop land in California to feed a horse, this would indicate the release of fully 300,000 acres of crop land for other uses, or to lie idle. Doubtless pasture land was released also. This release of farm land for other purposes is likely to continue for several years at least, as there are not enough colts on farms, either in the United States or in California, to replace half the horses that die or become unfit for use each year.

FIELD CROPS

The area of land in the Pacific Subtropical Crops Region from which crops were harvested in 1924 was about 5,400,000 acres. In addition there was nearly 900,000 acres of crop failure, as already noted.[9] Hay constituted about one-fourth of the crop acreage harvested, and the small grains over a fifth. Adding the acreage of corn and the sorghums brings the acreage in hay and grain to over one-half that of all crops. But, the value of these crops was not over one-fifth that of all the crops.

Alfalfa is the principal hay crop, constituting in 1924 over 40 per cent of the acreage in hay, but nearly 80 per cent of the production (Fig. 215).

[9] The acreage of crops harvested in all California in 1929 is estimated at about 6,830,000 acres, of which 4,730,000 acres are field crops, 1,700,000 acres are fruit crops and 400,000 acres are vegetable crops.

The acreage of small grains cut green for hay, which grow during the winter and need not survive the summer drought, was greater in 1924 than alfalfa; but the acre-yield was only one-fourth as great (Fig. 216). This grain hay is cut only once, whereas alfalfa is cut from three to six times yearly. In recent years the acreage of grain hay has been declining.[10] In many places, especially in low, moist lands, the native wild grasses are also cut for hay. The value of the tame hay crop of California averages about $75,000,000, and the wild hay crop about $1,500,000.

Barley is the principal grain crop, averaging about a million acres during recent years (Fig. 217). It is hardier and more drought resistant than wheat, and is much better adapted to the climate than corn, which needs a summer rather than a winter rainfall. Over half of the grain grown in the region is barley. The production is heaviest in the Sacramento and northern portion of the San Joaquin valleys, where the rainfall is more adequate than farther south. Only 13 per cent was grown under irrigation in 1919, according ing to the Census.[11] It is used locally for feed, and is also exported through San Francisco to Europe for malting. Sometimes it absorbs enough moisture en route to pay the freight. The barley crop of California ranges from $20,000,000 to $25,000,000 in value.

Wheat was formerly a very important crop in the region, but now occupies an acreage and has a value only about three-fourths that of barley. The decline in wheat production, which was rapid between 1899 and 1909, was owing in part to the use of the better lands for more intensive crops, in part to the depletion of soil fertility after 40 years of continuous cropping. As a Californian of long experience once remarked to the writer, "It was wheat, then barley, then rye, then goodbye." War-time prices caused a recovery in 1919 to half the acreage two decades earlier, and although the acreage is now only two-thirds the 1919 level, it is much greater than in 1909. Wheat is grown principally in the same districts as barley. Only 16 per cent of the acreage was irrigated in 1919. California wheat is soft, and is either used locally for

FIGURE 220.—The seeding and harvesting of rice in California is carried on in the same way as that of wheat and barley. The picture shows a tractor and combine-harvester picking up and threshing rice that has been cut and left in windrows. By using modern machinery California farmers are able to grow rice at so low a cost as to permit shipment across the Pacific Ocean and sale in Shanghai at a price often lower than the Chinese can afford to deliver it, despite the fact that the American farm laborer is paid a wage probably ten times that of the Chinese laborer. (Photograph from California Development Assn.)

[10] In 1928 the area in alfalfa was estimated at 1,011,000 acres, in grain hay at 546,000 acres, in wild hay at 150,000 acres, and the total hay acreage as 1,804,000 acres.

[11] The Census Bureau asked each enumerator to mark on the schedule the crop grown on irrigated land, but undoubtedly many times the enumerator forgot to do so, hence this and both preceding and subsequent figures giving proportion of the acreage irrigated are probably too small.

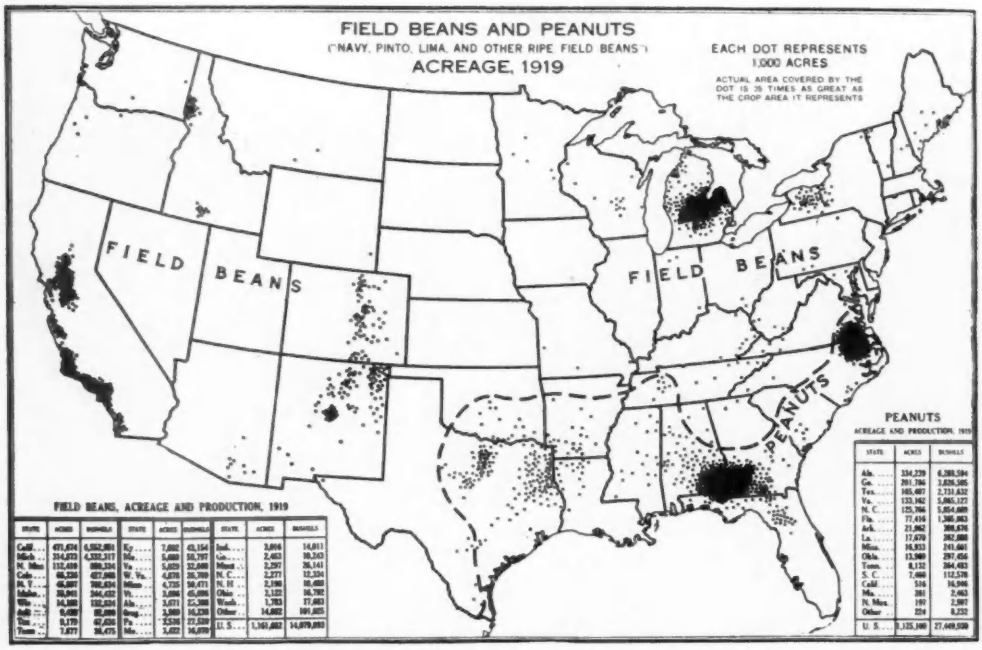
FIELD BEANS AND PEANUTS
(NAVY, PINTO, LIMA, AND OTHER RIPE FIELD BEANS)
ACREAGE, 1919
EACH DOT REPRESENTS
1,000 ACRES
ACTUAL AREA COVERED BY THE DOT IS 25 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS
FIELD BEANS
FIELD BEANS
PEANUTS
PEANUTS
ACREAGE AND PRODUCTION, 1919
FIELD BEANS, ACREAGE AND PRODUCTION, 1919

FIGURE 221.—California produces more dry beans than any other State, except Michigan. In Southern California nearly all the lima beans of the United States are grown, while in the coastal valleys to the north and in the Great Valley about half of the nation's crop of white beans was formerly raised. Now, however, the production of white beans in California is small compared with Michigan. California beans are shipped mostly to the Eastern States where the limas are used directly by the housewife, while many of the white beans are canned with pork and tomato juice, notably in Boston and Portland, Maine, and become the famous Boston baked beans of commerce. The lima beans are grown without irrigation in the fog belt near the coast, but most of the beans in the Great Valley are irrigated. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

flour or shipped to Europe and the Orient. The value of the wheat crop of California ranges, usually, from $15,000,000 to $20,000,000 in value.

Rice ranks third among the grain crops of the state. Its production is confined practically to the Sacramento Valley, where water for irrigation is more abundant than farther south. The area harvested has averaged about 150,000 acres in recent years, and production about 8,000,000 bushels, which is one-fifth of the nation's crop. A large proportion of the crop, especially when the price is low, is shipped to Japan and China. The use of modern machinery in seeding and harvesting enables the California rice grower to pay four dollars a day or more for farm labor and ship rice across the Pacific Ocean to countries where farm labor receives 40 cents a day or less (Figs. 219 and 220). The value of the crop averages about $10,000,000.

Although the acreage of oats is usually as large as that of rice, the value of the crop is scarcely a third as great. The oats are also grown principally in the Sacramento Valley, and are used locally for feed, mostly for horses. A little corn is grown in the region, 80,000 acres on the average, producing 2,500,000 bushels, or equivalent, which is about that of an average county in the Corn Belt. The corn is found mostly in the central part of the Great Valley and in Southern California. About a fifth of the crop is cut for silage and

FIGURE 222.—Sugar beets are grown in the same districts as beans, and compete for the land with beans in some years. Sugar beets require a large amount of labor in plowing the land deeply, in planting, in thinning the plants in the row, then in cultivating and, finally, in harvesting, which is done largely by hand. In the picture, taken in Southern California, the beets have been lifted, the tops cut off and the topped beets placed in piles. It will be noted that there are ten laborers and the foreman working in the field. The beets will be thrown into wagons and hauled to the sugar factory promptly before their quality is lowered by fermentation. (Photo from Los Angeles Chamber of Commerce.)

practically all the grain also is used locally for feed. The acreage of the grain sorghums is now much greater than that of corn, and the yield per acre is about the same. The value per bushel, however, is less. These sorghums, which are grown mostly in the hot San Joaquin Valley, are better adapted to the dry summers than corn, which has the vitality of its pollen impaired by very dry air. However, the sorghums, like corn, are better adapted to a summer rainfall than to a winter rainfall type of climate. As both crops are grown during the summer, to secure the necessary heat, they are largely irrigated, 50 per cent of the corn and 75 per cent of the sorghums being irrigated in 1919, according to the census.

Three other crops, beside fruit and vegetables, are of great importance in several localities in the region,—dry beans, sugar beets, and cotton. The beans and the beets are grown largely in the same localities, and both were somewhat more important a decade ago than they are now. The beans are grown along the southern coast (Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties), in the Salinas Valley, and in the central part of the Great Valley (Fig. 221). Nearly the entire lima bean crop of the nation is grown in Southern California, mostly in the fog zone within ten

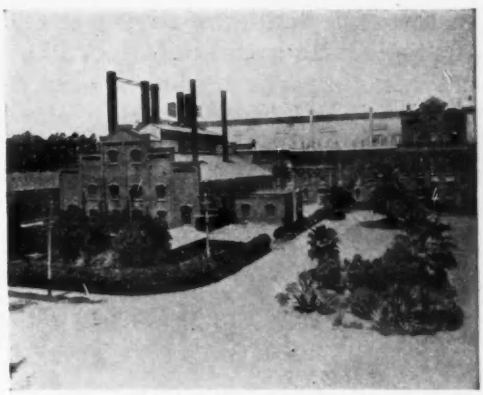

FIGURE 223.—This is one of the largest sugar factories in Southern California. The beets are dumped from the farmers' wagons or railroad freight cars into large, long bins, whence they are conveyed by a stream of water in a gutter to tanks for washing, after which they are sliced, heated in water to extract the sugar, and the juice treated by a number of processes. A sugar factory usually operates two to three months and then remains more or less idle for nine months. Most of the California sugar is used in the Western States, and its principal competitor is cane sugar from Hawaii. At present only 50,000 to 60,000 acres of beets are being grown in California, and the usual yield per acre of 8 to 10 tons of beets, produces one to one and a half tons of sugar. (Photo from Los Angeles Chamber of Commerce.)

miles of the coast, and where the average annual rainfall is only 10 to 15 inches. The lima beans are grown without irrigation, the fog apparently augmenting the rainfall and also reducing loss by shattering while harvesting, which is done by machinery. Pink, blackeye, small white, red Mexican and cranberry are also important varieties of beans, but these are grown mostly in the Salinas Valley or the Great Valley, where a large proportion of the crop is irrigated. The bean crop ranges from $13,000,000 to $25,000,000 in value.

The largest acreage of sugar beets is also along the southern coast, but the acreage in the lower Sacramento Valley is almost as large, while the Salinas and Santa Maria Valleys are also important centers of production (Fig. 222). In each of these areas there are one or more sugar factories (Fig. 223). The sugar beet crop of California now averages only about $4,000,000 in value.

Cotton is grown only in the interior valleys, mostly in the San Joaquin Valley and in the Imperial and Palo Verde valleys. The latter two valleys are located outside the Pacific Subtropical Crops Region. The production of cotton in the upper San Joaquin Valley has increased very rapidly in recent years, and cotton bids fair to become a very important crop in this valley. In 1924 the area in cotton in this valley exceeded 40,000 acres, and it is probably over twice as large today. The yield is from a half bale to a bale to the acre. Practically all the cotton is irrigated, and most of it is shipped to Japan, England, and Germany or to mills in Oakland and Los Angeles. The farm value of the cotton crop of California, including seed, was over $20,000,000 in 1929.

(NOTE.—*The rest of the instalment on the Pacific Subtropical Crops Region will be continued in the next issue.*)

LAND VALUES IN THE BLUE GRASS AND NASHVILLE BASINS

Raymond E. Murphy

Geographer, University of Wisconsin

"THE upland quality of the general regional slope of the Appalachian Plateaus is interrupted in Kentucky and Tennessee by lowlands of unusual size and importance. The Kentucky lowland is the Blue Grass country, famous for its rich limestone soils and its nutritious blue grass; the Nashville lowland or Central Basin is of equal importance, though it has for some reason never gained such general renown"[1] (Fig. 1).

The implied assumption that these two regions should be equally renowned is based on certain well-known facts regarding them. Both regions are topographic basins. Both basins were developed by the erosion of structural domes. Both are underlain chiefly by rocks of Ordovician age and are surrounded by rims of Mississippian rock. Both have residual soils resulting largely from the decomposition of Ordovician limestones. The soils of both regions have the reputation of being quite fertile and capable of supporting rich growths of blue grass. The fact that the two regions are near together and are both in the Interior Low Plateau Province makes any considerable climatic difference seem improbable.

How then can one explain the statement that the Nashville Basin "has for some reason never gained such general renown" as the Blue Grass Basin? There is no doubt that the latter has been mentioned much more frequently in the literature and is much oftener pointed out as an agricultural district *par excellence.*

This difference in the reputation of the two districts is borne out by a comparison of the land values based on the 1925 Census of Agriculture (Fig. 2). Thus, only one of the Nashville Basin counties has a land value greater than $50 per acre (Davidson County, in which Nashville is located, $74 per acre) while over half (19 out of 34) of the Blue Grass Basin counties have a land value exceeding $50 per acre, two counties have a land value per acre of between $100 and $150, and one, Fayette, $154. (For identification of the various counties, see Fig. 3.)

Physiography and Topography

That portion of the Cincinnati Arch lying south of the city of Cincinnati, Ohio, is divided into two structural domes. These two subdomes of the Arch originally extended above the general level of the surrounding country. In the base-leveling which ensued the cap rock of the domes was either entirely removed or greatly thinned. Softer rock underlay the cap rock so that with further uplift erosion progressed more quickly on the sites of the domes than elsewhere. Lowlands or

[1] Isaiah Bowman: "Forest Physiography". John Wiley and Sons, New York, 1911, p. 700.

FIGURE 1.—Eastern half of the United States, showing location of Blue Grass and Nashville Basins and their relation to the various physiographic provinces. (Adapted from various sources.)

basins resulted, surrounded by uplands underlain by the hard strata such as once formed the cap rock of the domes. These two lowlands are known as the Blue Grass and Nashville Basins.

The two basins are alike topographically in that they consist dominantly of gently rolling country (Figs. 4, 5, and 6). Considered in more detail, differences become apparent.

Although there are local variations due to the character of the underlying rocks, the Blue Grass Basin is, in the main, a large area of gently rolling country with a narrow belt of knobs or hills surrounding it (Fig. 7). Some of these knobs are capped by Mississippian rocks while others owe their origin to the former presence of such a capping layer. Outside of this knobby belt is the true rim of the basin. The gently rolling topography of the central region is interrupted by several streams with deep and narrow valleys.

The extent of the gently rolling topography is considerably less in the Nashville Basin. Such topography is found there in many places, as in much of Rutherford County, but knobs, confined to the edge of the Blue Grass Basin, are not as limited in the Nashville Basin (Figs. 5 and 8). Knobs are found, for example, in southwestern Rutherford County, over much of southern Marshall and Bedford Counties and over part of Maury and western Williamson Counties. All such knobs are not capped by Mississippian rocks. Although many of them are, others had a capping of resistant Mississippian rocks preserved until relatively recent times geologically when removal by erosion left a knob of Ordovician rocks. The streams of the Nashville Basin, such as Stones River and the Cumberland, do not have valleys that are nearly as deep and narrow as those of equivalent size in the Blue Grass. Thus, the Cumberland River on the Nashville Topographic Sheet has cut a little over 100 feet below the level of the surrounding basin floor. Stones River on the Murfreesboro Sheet has a valley showing a maximum depth beneath the level of the basin floor of 60 feet and that only in the northwest corner of the quadrangle. The Harrodsburg Sheet of Kentucky, where the Kentucky River runs more than 300 feet below the surrounding basin level, shows a marked contrast to the situation in Tennessee. Apparently, the two basins have undergone slightly different physiographic histories.

The Blue Grass Basin was evidently reduced to a plain cut in

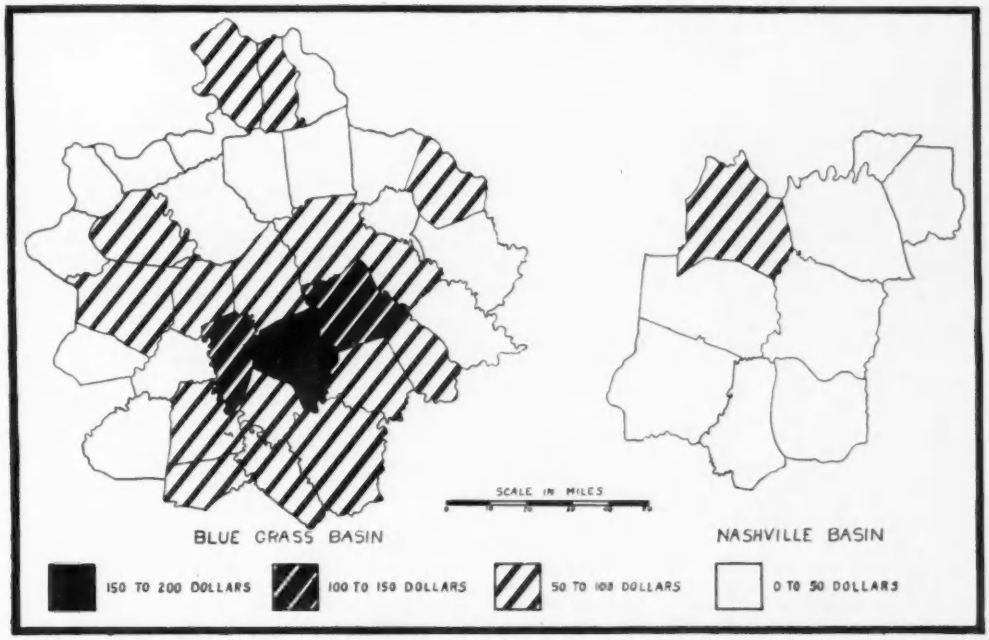

FIGURE 2.—Land values in the Blue Grass and Nashville Basins. The counties representing each basin were selected on the proportion of their area underlain by Ordovician rocks. A county having fifty per cent or more of its area underlain by Ordovician rocks was considered to be a basin county. (Based on U. S. Census of Agriculture, 1925.)

Ordovician rocks. That this plain was quite flat is shown by the absence of knobs over most of the Basin. On this low, level, land surface streams such as the ancient Kentucky meandered. A considerable uplift, possibly through further doming, gave the streams renewed vigor resulting in the entrenched valleys of today. The Basin floor is now in topographic youth with several streams flowing in deep narrow valleys across it.

The Nashville Basin was also reduced almost to a plain, but this plain was far from being as smooth as that of the Blue Grass Basin. The erosion cycle had not advanced as far as in the case of the Blue Grass Basin. Many knobs still projected above the fairly level floor of the Nashville Basin. When rejuvenation interrupted this cycle the uplift was not as great as that affecting the Blue Grass Basin, so that the streams have not had the incentive to cut as deep valleys.

The presence of scattered knobs or patches of knobs projecting above the general level of the Nashville Basin has very likely had some influence in determining the lower land values there. The Blue Grass Basin is probably more favored in the matter of topography since it lacks such scattered knobs, and the valleys which streams of the present erosion cycle have cut in its floor, though deep, are mostly quite narrow, leaving large uninterrupted areas of gently rolling to flat topography between them.

SIZE

The area of the Blue Grass Basin of Kentucky is about 8,000 square miles, while the area of the Nashville Basin is approximately 5,400 square

FIGURE 3.—The Blue Grass and Nashville Basins, showing county names, principal rivers, and cities of 2,500 population or greater. The area of the circles is proportionate to the size of the cities. Population of cities based on 1920 Census.

miles. This latter figure includes considerable land in which knobs are plentiful, corresponding to the border regions of the Blue Grass Basin.

The greater size of the Blue Grass Basin would tend toward higher land values there than in the Nashville Basin. That valuable property

FIGURE 4.—Typical topography of the central part of the Blue Grass Basin. Two important activities of the region are represented in this view, the raising of sheep and the raising of thoroughbred horses. The farm is one of several large stock farms situated near Lexington in the Inner Blue Grass. (Photograph from R. L. McClure, Lexington, Ky.)

FIGURE 5.—Typical topography of the Nashville Basin; flat to gently rolling land in the foreground with an isolated hill or knob in the background. The presence of these knobs here and there in the Basin probably results in lower average land values than would otherwise be the case. About five miles southwest of Murfreesboro in Rutherford County, Tennessee. (Photograph from Agric. Experiment Station, Knoxville, Tenn.)

keeps up the value of adjacent property is a fact too well known to require elaboration.

SOIL

The soils of these two regions are proverbially rich, but, as pointed out earlier, that of the Blue Grass Basin enjoys a better reputation than that of the Tennessee area.

FIGURE 6.—Scene near Mt. Pleasant, about ten miles southwest of Columbia, in Maury County, Tennessee. The view was taken from one of the knobs of the region and shows in the background some of the gently rolling farm land that has given the Nashville Basin such a good reputation as an agricultural district. Phosphate is mined in this area. (Photograph from Walter F. Pond, State Geologist of Tennessee.)

The soils of both regions (though not of the knobs) were derived mostly from Ordovician rocks which were dominantly limestones. These soils were, originally at least, high in lime and had a fairly high phosphorus content.

Shaler refers to the soil of the two basins saying, after a discussion of the Blue Grass Basin: "The blue limestone soils are continued southward through Tennessee to the northern border of Alabama, but owing to the sandier nature of the rock in that section they produce somewhat less fertile soils than in the central portion of Kentucky."[2] Descriptions of the geologic character of the rock from which the soil was derived in these two regions do not seem to bear out Shaler's suggestion that the parent rocks of the Tennessee soil were sandier.

The Kentucky region has been subdivided into the Inner Blue Grass,

[2] N. S. Shaler: "The United States of America." D. Appleton and Company, New York, Vol. 1, 1894, p. 106.

FIGURE 7.—Transition from Blue Grass Basin to Knobs. Scene about eight miles south of Danville, Kentucky. The belt of knobs surrounding the Blue Grass Basin is narrow. This is in marked contrast to the way in which knobs are scattered over the Nashville Basin. (Photograph by Prof. A. M. Miller.)

the Eden Shale Belt, and the Outer Blue Grass on the basis of the character of underlying rock and the manner in which it is reflected in topography and soil (Figs. 4, 9, and 10). The Nashville Basin has not been subdivided in this way so a comparison on this basis cannot be made. The oldest rocks exposed in the Nashville Basin are as old as, or older than, those of the Inner Blue Grass, and Mississippian rocks form the rims of both basins. The characters of the rocks of the various ages seem much the same in the two regions. The bed rock in both regions is high in phosphorus. In short, the information available does not indicate an explanation of the difference in land values in the two basins on the basis of difference in underlying rock formations and consequent difference in soil.

Soil surveys have been made of a few counties in each region. They seem to indicate quite similar soil types in the two basins, but detailed comparisons based on these soil surveys are impossible, due to the limited area that has been thus covered.

FIGURE 8.—Scene in the southeastern part of Davidson County, Tennessee. Hills, such as the ones shown in the background here, are probably partly responsible for the lower average land values in the Nashville Basin than in the Blue Grass Basin. (Photograph from Walter F. Pond, State Geologist of Tennessee.)

CLIMATE

Both of these regions enjoy a climate which is quite favorable for agriculture.

The mean annual precipitation is about 40 to 45 inches in the Blue Grass Basin, while that in the Nash-

FIGURE 9.—Patchy cultivation of some of the more badly eroded land in the eastern part of Shelby County, Kentucky. This is in the Eden Shale Belt the soils of which are commonly of lower fertility than those of either the Inner or Outer Blue Grass between which it lies. (Photograph from the U. S. Dept. of Agric.)

ville Basin is about 48 to 49 inches. Distribution throughout the year is about the same for the two regions.

Temperatures are in general somewhat higher in the Nashville Basin than in the Blue Grass Basin—a natural consequence of the difference in latitude. The length of the growing season averages about 180 days in the Blue Grass Basin compared to slightly over 200 days for the Nashville Basin.

The climate of the Nashville Basin seems if anything slightly the more favorable of the two for agriculture.

LOCATION

In the matter of location the Blue Grass Basin seems to be the more favored of the two districts (Figs. 1 and 3).

The Blue Grass Basin borders the Ohio River, a natural avenue of transportation, and is penetrated by a river navigable for small boats, the Kentucky. The Nashville Basin can only be reached by water by a long trip from the Ohio on the Cumberland River which is comparable to the Kentucky in navigability.

FIGURE 10.—View in the Outer Blue Grass near Shelbyville, Kentucky. The crop in shock is hemp, a crop which is no longer important in the Blue Grass Basin. Corn, hay, wheat, and tobacco are the principal crops of this vicinity. (Photograph from the U. S. Dept. of Agric.)

The Blue Grass Basin is favored in its proximity to large cities, the most notable examples being Cincinnati and Louisville, both located just outside the Blue Grass Basin. The development of both of these and particularly Cincinnati has been influenced by the presence of the fertile

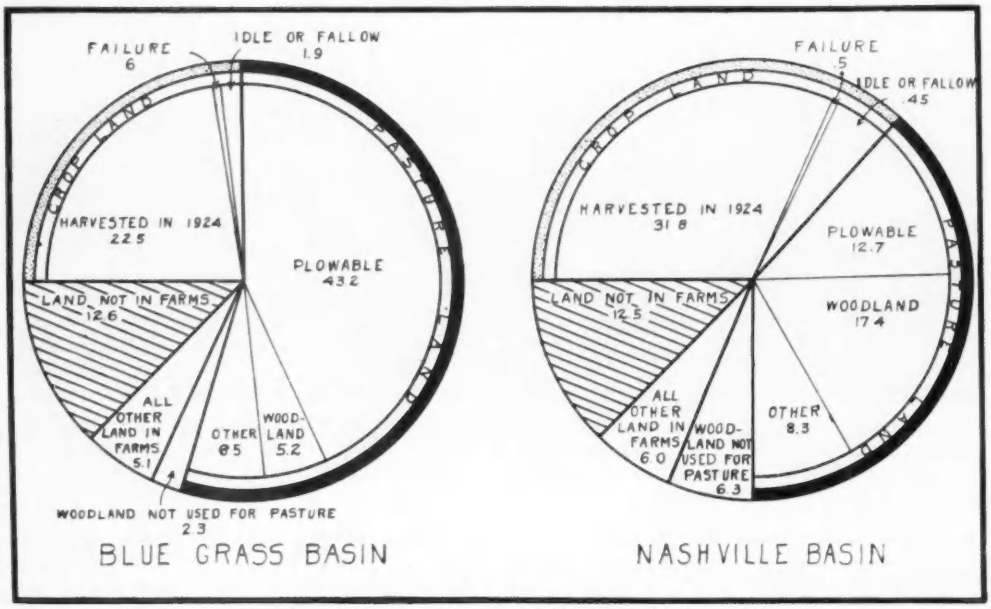

FIGURE 11.—Land utilization in the Blue Grass and Nashville Basins. Figures given are in each case per cents of total areas of the basins. (Based on figures from the U. S. Census of Agriculture, 1925.)

lowland though the influence of the Blue Grass Basin has probably not been the primary one in either case. What has been the effect of these cities? Undoubtedly land values in the Blue Grass Basin are on the whole somewhat higher than they would have been without these large cities nearby.

The main arteries of trade in the United States run east-west and lie to the north of the Ohio River. The Blue Grass Basin lies nearer to these main paths of trade than does the Nashville Basin.

The Blue Grass Basin merges at the north into the valuable farming lands of Indiana and Ohio. The Nashville Basin, on the other hand, is entirely surrounded by relatively poor land. These conditions favor higher land values in the Blue Grass Basin.

HISTORY

The first permanent settlers for both the Blue Grass Basin and the Nashville Basin came by way of the Great Valley. From there, part went northwest to the Blue Grass by way of the Wilderness Road, and part, slightly later, went across country to the southwest to Nashville.

The Blue Grass Basin was from the first favored in the matter of greater accessibility. When the earliest settlers came down the Great Valley, they found the journey into the Blue Grass Basin through Cumberland Gap shorter and easier than the trip overland to Nashville or the alternative trip down the Tennessee and up the Cumberland River.

Later when people and merchandise came down the Ohio River from Pittsburgh the Blue Grass Basin was again at an advantage. Michaux, who visited these two regions in 1802, wrote regarding Nashville: "The price of labour is higher in this town than at Lexington, and the same disproportion exists between this price and that of provisions. There ap-

FIGURE 12.—Scene of the birthplace of Man O'War, famous Kentucky race horse, about four miles north of Lexington, Kentucky. The raising of thoroughbred horses has been an important factor in the maintaining of high land values in this part of Kentucky. (Photograph from R. L. McClure, Lexington, Ky.)

peared to be from fifteen to twenty shops, which are supplied from Philadelphia and Baltimore, but they did not seem so well stocked as those at Lexington, and the articles, though dearer, are of an inferior quality. The cause of their being so dear may be in some measure attributed to the expense of carriage, which is much greater on account of the amazing distance the boats destined for Tennessee have to go up the Ohio. In fact, after having passed by Limestone, the place where they unload for Kentucky, and which is four hundred and twenty miles from Pittsburgh, they have still to make a passage up the river of six hundred and nineteen miles to reach the mouth of the river Cumberland, and a hundred and eighty miles to arrive at Nashville, which, in the whole, comprises a space of one thousand five hundred and twenty-one miles from Philadelphia, of which twelve hundred are by water."[3] Michaux uses "up the river" where he evidently means down the river. The town of Limestone referred to is now known as Maysville and is located in Mason County.

In the shipping of produce down river to New Orleans the settlers of the Nashville Basin were probably at a slight advantage, and they certainly were favored on the return trip overland via the Natchez Trace.

Early in the history of the two basins greater accessibility, greater size, and possibly slightly smoother topography gave the Blue Grass Basin the reputation of being the more attractive of the two. As a natural consequence the Blue Grass Basin had several thousand settlers before the first permanent settlement in the Nashville Basin was established.

Other influences that might be classed as historical are the bringing of race horses into the Blue Grass and the establishment of the tobacco industry.

Race horses were brought into the Blue Grass Basin just after the Revolutionary War and the development of racing and the breeding of race horses has been an important factor in determining the high land values of the Inner Blue Grass.

The tobacco industry was started in the Blue Grass by the early settlers but did not assume great importance until after the appearance of White Burley in Brown County, Ohio, in 1864. This new type soon gained in general favor and displaced the dark tobaccos which were grown at that time in the Blue Grass. It is at present more valuable than the dark tobaccos of western Kentucky. The fact that this new type was discovered in an Ohio county adjacent to the Blue Grass doubtless is partly re-

[3] F. A. Michaux in "Early Western Travels," edited by Reuben Gold Thwaites. Arthur H. Clark Company, Cleveland, 1904, pp. 251–252.

sponsible for the widespread growing of the type in the Blue Grass Basin today. The tobacco industry, having started in the Blue Grass Basin, acquired a reputation in the district. Thus, as tobacco, particularly this White Burley became a valuable crop, land values rose.

LAND UTILIZATION

The most outstanding features of land utilization in these two regions are the larger proportion of crop land in the Nashville Basin and of plowable pasture land in the Blue Grass (Fig. 11). The greater number of horses, sheep, and cattle raised in the Blue Grass is a reflection of this difference.

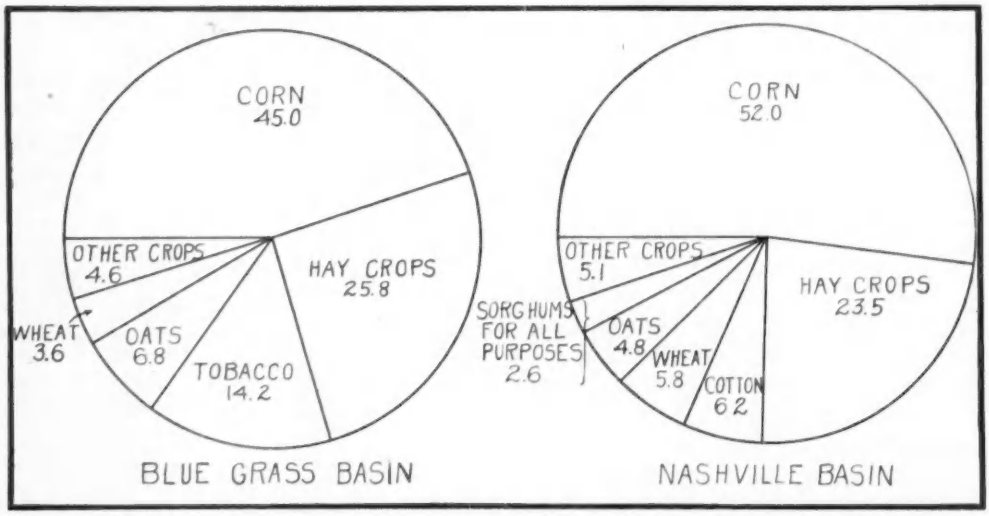

FIGURE 13.—Utilization of crop land harvested in 1924 in the Blue Grass and Nashville Basins. Figures given in each case are per cents of the total crop land harvested. (Based on figures from the U. S. Census of Agriculture, 1925.)

The development of horse racing and the breeding of thoroughbred horses in the Blue Grass (Fig. 12) deserves further mention. This industry has been referred to already as having gotten its start in the region just after the Revolutionary War. That the industry developed to a greater extent in the Blue Grass than in the Nashville Basin is probably due in considerable part to chance although the greater accessibility, greater size, and slightly smoother topography of the Blue Grass Basin were probably factors in the situation. That the industry should be largely concentrated in Fayette County rather than spread out over the Blue Grass is a consequence of the central location of Fayette County, the superior soil and hence superior pastures of the Inner Blue Grass as compared with other parts of the Basin, the presence of the city of Lexington, and various other influences. That the growing of thoroughbred horses has had an effect on land values is suggested by the fact that Fayette County, the principal seat of this industry in these two basins, has the highest average land values of any county in either basin. This influence is particularly important in Fayette County and through it the surrounding counties have been somewhat affected. As will be mentioned later the high

land values in the Blue Grass in general are probably due in considerable part to the tobacco industry but in Fayette County there is also the important influence of the thoroughbred horse industry. Still another factor enters into the matter of high land values in Fayette County and that is the presence of the city of Lexington.

Utilization of crop land differs in one or two important respects in the two basins (Fig. 13). A larger proportion of the crop land is devoted to corn in the Nashville Basin than in the Blue Grass Basin and very little tobacco is raised in the Nashville Basin (Fig. 14) while it makes up 14.2 per cent of the entire acreage cropped in the other (Fig. 15). Some cotton is grown in the Nashville area, while there is none grown at all in the Blue Grass.

What, if any, relation exists between crops grown and land values? If one compares the map showing value of crops per acre (Fig. 16) with the tobacco production map (Fig. 14) and the map showing value of land per acre (Fig. 2) many similarities are seen. The Nashville Basin counties grow little tobacco and they have low crop values per acre and low land values per acre; the Blue Grass Basin counties, particularly those of the central Blue Grass, grow a great deal of tobacco and they have high crop values per acre and high land values per acre.

A partial explanation of this situation seems to lie in the nature of tobacco as a crop. It has a high value per acre, many times that of either corn or cotton. That being the case, tobacco land is of higher value than corn or cotton land notwithstanding the fact that after one or two crops of tobacco the land must be planted in blue grass and left in pasture for several years. The greater development of the tobacco industry in the Blue Grass

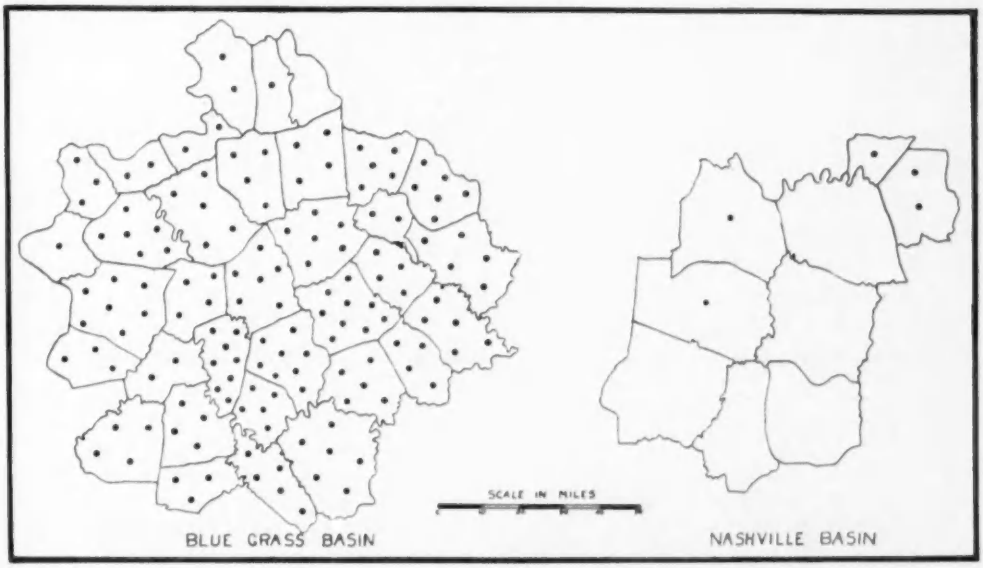

FIGURE 14.—Tobacco production in the Blue Grass and Nashville Basins for 1924. Each dot represents 1,000,000 pounds. (Based on figures from the U. S. Census of Agriculture, 1925.)

may therefore furnish a partial explanation for the difference in the land values.

If tobacco is such a valuable crop, why isn't it grown to a greater extent in the Nashville Basin instead of corn and cotton, which have considerably less value? As in the case of the thoroughbred horses there has probably been a large element of chance. Tobacco growing just got started earlier in the Blue Grass Basin and developed into an important industry. Also, it fitted in very well with the thoroughbred horse raising of the Inner Blue Grass and the more widespread raising of work horses, cattle, and sheep. Tobacco requires a fertile soil of high humus content and these conditions are best met by plowing up old sod. In order that this practice may be kept up and tobacco planted only on this newly broken ground the farmer must maintain a large acreage of pasture land compared to his tobacco acreage. Tobacco growing just did not happen to be started in the Nashville Basin until the growing of corn and cotton had been established there. It seems probable that the element of chance

FIGURE 15.—A field of tobacco near Lexington, Kentucky. Some tobacco is grown especially for the seed. The pods, after the bloom has fallen, are covered with paper bags to protect them and insure perfect seed. The extensive raising of tobacco probably accounts in large part for the high value of crops per acre in this region. (Photograph from R. L. McClure, Lexington, Ky.)

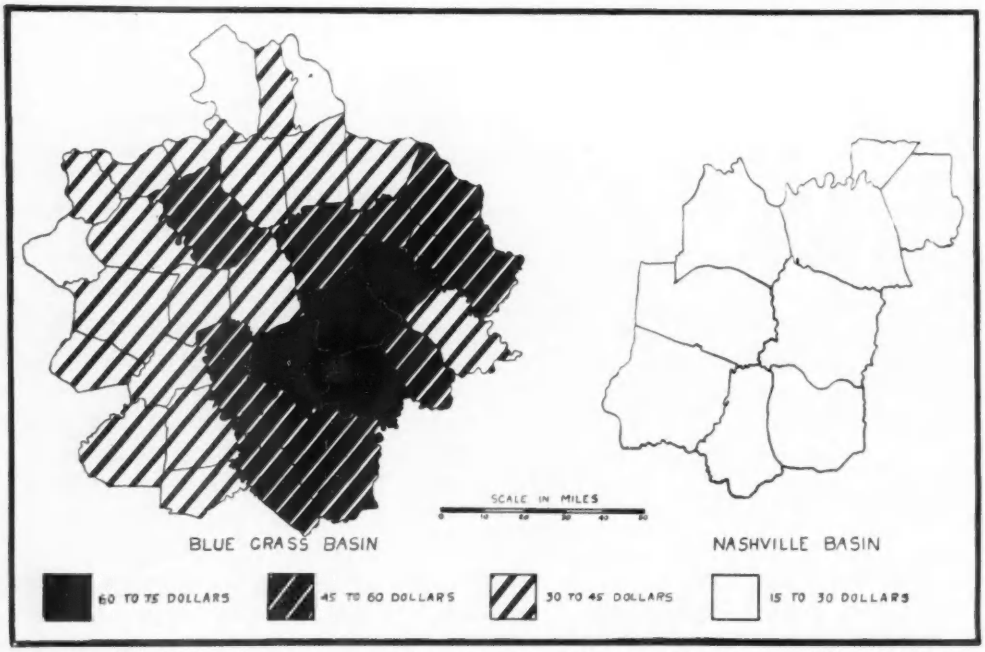

FIGURE 16.—Value of crops per acre of crop land for 1924 in the Blue Grass and Nashville Basins. (Based on U. S. Census of Agriculture, 1925.)

has been more important here than soil differences and that eventually the Burley tobacco of the Blue Grass may be grown extensively in the Nashville Basin.

SUMMARY

The 1925 Census of Agriculture shows land values in the Blue Grass Basin of Kentucky averaging considerably higher than those of the Nashville Basin of Tennessee although these two basins seem at first consideration to be identical in their natural equipment.

The Blue Grass Basin probably has a larger proportion of level land than the Nashville Basin. The Blue Grass Basin is larger and it is more favorably located. From the visits of the earliest settlers the Kentucky area has enjoyed the better reputation of the two, probably due to greater accessibility, greater size, and somewhat larger proportion of level land. The raising of thoroughbred horses is and has been much more important in the Blue Grass Basin, or, at least, in Fayette County, than in the Nashville Basin, and this has been partly responsible for the high land values of the central part of the Blue Grass. The tobacco industry also has become very important in the Blue Grass Basin, and, since tobacco is a valuable crop, high land values have resulted, with little tendency to speculation.

BOOK REVIEWS

DEPARTMENT OF COMMERCE

Bureau of Foreign and Domestic Commerce

The Market Data Handbook of the United States. By Paul W. Stewart. Price, $2.50.

Contributions of an outstanding character recently have been issued by the Bureau of Foreign and Domestic Commerce. *The Market Data Handbook of the United States* by Paul W. Stewart of the Domestic Commerce Division pioneers in a field where the business world urgently has needed reliable and concrete information; namely, the territorial extent and the economic composition of market areas. Three general types of markets are considered: the general consumer, the farm, and the industrial market. The county was selected as the physical unit, primarily because it is the smallest political unit for which satisfactory statistics are available.

Statistics on the general consumer market cover such facts as population, manufacturing, agriculture, mining, bank deposits, number of individual income tax returns, number of families with telephones, number of passenger automobiles, and number of trade outlets.

The farm market covers the number of farms, the farm population, land areas, value of crops, farm values, and others. For the figures on the industrial market, a special compilation was made by the Bureau of the Census using the 1927 Census of Manufactures. This gives the first figures by counties since the 1919 Census.

Extensive new data have been collected and presented for the first time, in addition to material from other government departments, and from many private sources.

Four maps accompany the volume, representing different phases of the market territory problem.

These valuable and well-organized statistical data afford an opportunity for the geographer in making a study of the geographic element inherent in many marketing problems.

Port Studies in Coöperation between the Bureau of Foreign and Domestic Commerce and U. S. Shipping Board.

The Transportation Division has, in coöperation with the United States Shipping Board, published two port studies, and a bulletin giving complete statistical data on foreign bunkering stations.

The port studies are based upon careful field work.

The Port of Hamburg. By Ralph I. Schneider of the United States Shipping Board. Foreign Port Series No. I. Price, $1.00.

This study presents in detail the description, port organization, physical facilities, cargo handling methods, equipment and labor, port charges, communication, port commerce, hinterland, rate conferences and railway rates, together with the economic and industrial phases of the free port of Hamburg. The maps in the pocket in the back cover illustrate many phases of the text, showing port facilities, the Warehouse City, principal railways in Germany, principal inland water systems in Germany, traffic for United States ports in Hamburg, and several others. The maps are clearly drawn, and well executed in blue, black, and white.

The book as a whole contains much material of value to the geographer, and the detailed statistical tables on commerce of the Port of Hamburg, and origin and destination of rail-borne commerce of the Elbe River port furnish opportunity for interesting geographical studies.

The Port of Liverpool Including Birkenhead and Garston. By Edward P. Cotter. Foreign Port Series No. 2. Price, $1.00.

This study contains the same material for Liverpool as that described above for the Port of Hamburg, including some excellent maps.

The field work of several months in each of these ports was supplemented by intensive study here at home, and the manuscript was in each case sent to the port officials abroad for a final and most meticulously careful check. Probably no book has been issued containing the amount of reliable and detailed material on either of these ports. It will be of immeasurable value to all geography students of trade problems. In fact each volume in itself is challenge for a geographer to make a careful geographic analysis, such as was not permitted to the authors in the instructions under which they worked.

Survey of Current Business, February, 1930. Semi-annual number. No. 102.

This survey is designed to present each month a picture of the business situation by setting forth the principal facts regarding the various lines of trade and industry. At semi-annual intervals, detailed tables are published giving for each item monthly figures for the past two years and yearly comparisons, where available, back to 1913.

Foreign Trade in Fresh Fruits. By Daniel J. Moriarty. Trade Promotion Series No. 90. Price, 25 cents.

The United States is ever increasing its production of fresh fruit. Doubling of the value of exports of fresh fruits between 1923 and 1927 has induced growers, exporters, and others engaged in this industry to take a greater interest in marketing their produce abroad. In 1928 the United States exported 56 million dollars' worth of fresh fruits.

Dried-Fruit Industry and Trade of South Africa. By Cecil M. P. Cross. Trade Information Bulletin No. 676. Price, 10 cents.

As one of the regions where the production of fruit is increasing, the Union of South Africa is of interest to dried-fruit producers and exporters in the United States. This bulletin outlines the history, present status, and prospects of the fruit industry in South Africa, and should prove of interest to American exporters of dried fruits.

Market for Sawmill and Woodworking Machinery in Mexico, Guatemala, Panama, Cuba, and Porto Rico. Trade Information Bulletin No. 675. Price, 10 cents.

This bulletin has been prepared to assist the American exporter of this type of machinery to determine the present and potential demand for his particular product and to devise the most effective methods for introducing new machinery and increasing the sales of lines already established. A good description is given of sawmill and woodworking activities and methods now being followed in each of the markets covered. It shows the types and sources of machinery now in use, contains practical information on the best ways to secure new business, and includes numerous other details.

The Margarine Industry of Europe. By E. L. Thomas. Trade Information Bulletin No. 677. Price, 10 cents.

This publication gives information on the margarine production, trade and consumption of various European countries, outlines the commercial practice followed, and sets forth the legislation which affects the industry.

Markets for Fuel-Oil Burners in the Eastern Hemisphere. Trade Information Bulletin No. 679. Price, 10 cents.

During recent years there has developed a foreign demand for American fuel-oil burners and parts, but the importance of that market is demonstrated by the fact that exports from the United States under this heading have increased approximately 48 per cent.

The Market of Foodstuffs in Guatemala. By Trade Commissioner H. P. Macgowan. Trade Information Bulletin No. 678. Price, 5 cents.

Foodstuffs of various kinds to the value of about 4 million dollars are imported annually into Guatemala, and it is estimated that about 90 per cent of the total is supplied by the United States. Some of the principal imports are flour, rice, wheat, canned fruit and vegetables, crackers and biscuits, packing-house products, dairy products, and dried fruit. There is only a small market for some of these products, but the demand for others is increasing.

U. S. COAST AND GEODETIC SURVEY

Distances Between United States Ports. Price, 10 cents.

This recently issued publication should prove of value to geography instructors and students and to those interested in the factors affecting distance, along a route marked by aids to navigation and affording a safe depth for the maximum draft that can enter both harbors. Distances can be obtained between practically any two ports of the United States, its territories, and its possessions. Tables are given which show distances between ports on the Atlantic, Gulf, and Pacific coasts; on the Atlantic coast inside routes; on the Hudson, Mississippi, and Ohio Rivers; on the Great Lakes; in the Virgin Islands, Porto Rico, Philippine, and Hawaiian Islands; and between the United States and a few foreign ports; together with tables showing time required to run various distances at different speeds.

The Bowie Method of Triangulation Adjustment. By Oscar S. Adams. Special Publication No. 159. Price, 10 cents.

This publication contains a discussion of the new method for the adjustment of a triangulation net as applied in the western part of the United States.

BUREAU OF FISHERIES

Fishery Industries of the United States, 1928. By R. H. Fiedler. Fisheries Document No. 1067. Price, 35 cents.

This report constitutes a yearbook on fishery statistics of the United States as well as a summary of activities of the division of fishery industries.

BUREAU OF MINES

Summarized Data of Lead Production. By Lewis A. Smith and others. Economic Paper 5. Price, 15 cents.

This paper deals with the production of lead since 1800 and is the fourth of a series of Bureau of Mines papers that, when completed, will cover the production of all the common metals.

Analyses of Maryland Coals. Technical Paper No. 465. Price, 15 cents.

One of the important functions of the Bureau of Mines is the analysis of samples of coal from every coal-mining State and from Alaska. These analyses are being published for the use of Government officials and the public. In connection with the analytical data showing the composition and quality of the coals of the States, consumers, producers, and the general public will be interested also in a brief description of the geologic structure of the coal basins, the typical mining conditions in the different districts, and the principal economic data of the industry.

HELEN M. STRONG.

Stamp, L. Dudley. *Asia, an Economic and Regional Geography.* 616 pp.; 322 illus. E. P. Dutton and Company, New York and London, 1929.

This volume is one of the first serious texts on the geography of Asia. Despite certain disadvantages of organization and balance, it is the best single reference book available and should find wide use in college classes and by the general reader. Asia as a continent has been singularly neglected by the modern interpretative geographer, partly due, no doubt, to the fact that so little is known of large areas. The wide-open spaces in the heart of Asia have been a convenient hiding place for many of the mysteries which still puzzle scientists, but the rising nationalism and increasing economic significance of the continent make it necessary that the West give attention to its geographic setting. To this end, Dr. Stamp has made a real contribution.

The book opens with seven brief chapters devoted to the continent as a whole in which the major outlines of the structure, climate, vegetation, population, and exploration are well presented. The last chapter in this part of the book includes numerous comparative diagrams showing Asia's share in world production.

The bulk of the book deals with the political units of the continent. In most cases these are discussed in terms of regions, but there is no unified description or map of the regions of Asia as a whole. Under each country there is a discussion of the physical features of the environment, such as the physiography, structure and climate, together with material on agriculture, and the population. The first chapter is entitled "Turkey—the Threshold of Asia," and is followed by "Arab Asia" and "The Iranian Plateau." In view of the fact that the author is most familiar with India, it is but natural that this chapter should be the most detailed. Nearly 200 pages are devoted to "The Indian Empire," more than half of which is made up of a survey of the 22 natural regions. Much of this material is taken from the author's earlier books, and is particularly valuable for its material on land utilization. This chapter occupies about one-third of the book, which would seem to be an undue share for India. This fact is partially justified because the book is written primarily for British students. The next two chapters are entitled "Ceylon" and "Southeastern Asia and the East Indies."

The good balance which the book shows thus far breaks down in the eastern and northern sections of the continent. "China," "The Dead Heart of Asia," "The Japanese Empire," and "Asiatic Russia" have but 150 pages together, and the analysis is less satisfactory than in the preceding chapters. In view of the size and population of China and the world position of Japan, it would seem that each one should receive at least as much space as India. Unfortunately no such wealth of statistics or maps is available for China as for India, but the author has not made complete use of the large amount of material in such publications as, for example, the *China Journal of Arts and Science* and the *Chinese Economic Journal.* The bulk of the chapter on China consists of material drawn from Roxby on regions; Baker, LaFleur, and Foscue on agriculture; Fisher on history; and other writers. This treatment does not lend itself to a unified or entirely true picture of the country. The dot map of rice distribution on page 463, for instance, does not show the abrupt northern limit of extensive rice culture, and its preparation on a hypsometric base gives a very erroneous picture of land forms in south China. The political treatment is in terms of pre-1911 provinces, and none of the maps are accurate for 1929. Numerous minor errors have crept into this portion of the book, many of which are perhaps unavoidable for one who has not travelled extensively in China.

The general arrangement of the book is factual rather than interpretative, and there is little direct attempt to show the relationship between man and his environment. The book contains 322 diagrams and maps, but no pictures. Many of the maps are without names or scales, and the use of solid black does not give very satisfactory results. The numerous references given in the footnotes are a distinct advantage. A very wide range of material is included in the book, and it fills a distinct need.

GEORGE B. CRESSEY.

Lippincott, Isaac. *Economic Resources and Industries of the World.* xxii and 635 pp.; maps and illustrations, index, and table of contents. D. Appleton & Co., New York, 1929. $5.00.

Economic Resources and Industries of the World is an up-to-date treatise on the world's crops, products, minerals, and other raw products, emphasizing the factors in their development and their world distribution. The purpose seems to be not only to provide a source book of information on the subject, but to emphasize throughout the work the ever-growing economic interdependence of peoples. He points out that economic penetration has become an established policy, not only for the further expansion of home industries, but for the development of the more backward regions to the point where they may yield their substances in abundance. The word "industries" is used in its broad sense and not in its narrower meaning which makes it synonymous with manufacturing.

A first glance at the contents and organization of the book reveals very little difference from many of our economic geography texts, but closer examination makes it evident that it emphasizes primarily economic matters, such as the effects of relative costs of production, the influence of the human factors in production, the effects of transplanted enterprises, financial power, ownership of ocean shipping, systems of

trade, and historical development of trade; and deals subordinately with location and extent of resources, routes of materials to market, and the physical environmental conditions of development which the geographer would have emphasized.

Part I contains five chapters on discussions of the factors in the development of the resources and industries. Part II comprises eighteen chapters on distribution of world resources including minerals and metals, agricultural crops, livestock, vegetable oils, spices, forest resources, and petroleum. Part III discusses in nine chapters the resources and industries of certain countries, the names and page allotments to each being as follows: United States and Canada, 15 pages; Latin America, 15 pages; United Kingdom, 15 pages; British Empire, 16 pages; Germany, 13 pages; France, 13 pages; other European countries, 14 pages; and Asia, 16 pages. The final chapter discusses the Economic Prospect, bringing out the fact that industrial progress has brought with it the fear of exhaustion of resources, the discovery that resources are unevenly distributed over the world, and the realization that nature's scheme does not correspond to political boundaries. Trade must make good this shortage and these defects. It indicates that concern is unnecessary for certain materials that are inexhaustible or that can be replenished—water, soils, and forests—but that the real problem involves the waste and exhaustion of such resources as coal, iron, lead, zinc, and petroleum. The extent of this problem rests upon the extravagance of use, the actual amounts in reserve, and to a large extent upon the future contributions of human genius, improved methods of discovery and extraction which will make continued large scale consumption possible without unduly rapid exhaustion.

A fault of the book is its lack of adequate illustration. The total of 71 pictures, maps, graphs, and charts scarcely suffices for a book of 635 pages on such a subject. Also, on some of the world map illustrations, where the equal area projection is used, adapted from J. Paul Goode's Homolographic map, the parallels and meridians are omitted, diminishing their effectiveness.

Chapters of the book are well delimited in subject and the questions at the ends of chapters will tend to make the book more easily taught. Instructors in courses in Conservation, Foreign Trade and Investments, and Foreign Markets will welcome this book as a college text. Though more economic than geographic, the geographer will find in it much material of interest and help.

BERT HUDGINS.

Killough, Hugh B. and Killough, Lucy W. *Raw Materials of Industrialism*. xix and 407 pp.; 1 map and 55 tables and graphs; bibliography and index. Thomas Crowell Company, New York, 1929.

For a general introductory economic survey of the sources and uses of the world's supply of the most important raw materials, the Killoughs have contributed a piece of literature of at least passing value, not only to geographers, but to general readers as well. The authors make no pretense of dealing with the material, much of which they admit has been assembled by economic geographers, in a geographic manner but, instead, approach the subject from the economic point of view. Not only have the problems involved in keeping the world's factories supplied with raw materials been briefly but adequately discussed in the 407 pages of text, but an endeavor has also been made to assemble and interpret some of the obscure facts and unheralded currents of thought on the economic aspects of resources and industries that have been brought to light in recent years.

The book is divided into 22 chapters, the first chapter of which is concerned chiefly with the increasing significance of industrial raw materials in the advance and progress of civilization. "The advance of civilization," according to the authors, "is measured by man's mastery over his physical environment and the progressive evolution of doctrines, institutions, and artistic interpretations."

The next six chapters come under Part I of the book which deals with population and the world's food supply. The relationship of food supply to population has, from earliest times, occupied the attention of leading thinkers and philosophers. During the past one hundred years, the world's population has more than doubled. Thinly populated areas favorable for human habitation at present are rapidly being occupied in a surprisingly short time. The land pessimist's echoing cry of "Standing Room Only" is slowly but menacingly becoming proverbial. The growth of population in congested areas, if it is to continue, must shift from a point of very low productivity under conditions of intensive agriculture to one of higher per capita productivity in mining and manufacturing. The remaining five chapters are devoted to a discussion of the most important of the world's food products such as wheat, rice, maize, and other cereals; potatoes and sugar; meat and fish; dairy and poultry products; and finally, fruits and vegetables. The material under each product is divided roughly into the following topics: (1) History and importance in the world's diet; (2) Present demand and future requirements; (3) Producing regions and methods of production; and (4) Elasticity of supply. Under the history, a brief but satisfactory account of the past importance of each commodity is presented. Statistics and opinions of experts on the subject are used in discussing the present demand and future requirements of the product, and an effort has been made to avoid a too analytical frame of mind. Only a brief résumé of the most important areas in the world is attempted under the topic of producing regions and methods of production, and a very excellent and satisfactory bibliography included at the end

of the book for those wishing to peruse or study further into the subject.

Part II, devoted to textile fibers, consists of three chapters, one on cotton, one on wool, and one on silk and rayon together.

Similarly, Parts III, IV and V, devoted to the crude products of the forest, metals and sulphur, and fuels and power, include chapters on wood, rubber, gold and silver, sulphur, copper, iron, coal, petroleum, and water power. The method of treatment is in many ways the same as that for the food products.

Part VI emphasizes the interdependence of nations for raw materials and calls attention to the fact that in weaving patterns of economic philosophy about a few selected raw materials, there is a danger of oversimplifying the subject and narrowing the vision so as to exclude some of the minor materials like steel alloys which are just as essential to the efficient operation of the world's greatest manufacturing industries. A brief mention of some of these commodities would include manganese, nickel, cobalt, chromium, antimony, tungsten, vanadium, tin, fertilizers, hides and skins, hemp and sisal, rattan, chicle, bristles, asbestos, shellac and jute, and a score or more of other minor materials.

Part VII, containing the remaining chapter, deals primarily with the influence of raw materials upon economic thought and practice.

The book contains one colored map of the world hidden away in the back of the book, too small and too highly generalized to be of any particular value, and 55 charts and tables which, considering the scope of the work, might be accepted as sufficient. The most commendable feature is the very excellent bibliography that is provided at the end of the book. Almost 400 separate references are listed included in which are some of the best and most valuable titles on the subject of raw materials that are in print today.

ANTHONY J. WEST.

Wolfanger, Louis A. *The Major Soil Divisions of the United States.* 150 pp.; 6 tables; 1 map. John Wiley and Sons, Inc., New York, 1930. $2.00.

As the title states, this book deals with the major soil divisions of the United States. His classification of soils and his method of treatment follow those of Dr. Curtis F. Marbut, with whom the author was for several years associated, though he uses a number of new terms in contrast with Marbut's well-known reluctance to burden the new soil science with a wholly new terminology.

The book consists of four chapters: namely, "Major Soil Divisions and Their Geographic Qualifications"; "The Pedalfers"; "The Pedocals"; and "Geographic Relationships." The one map locates the major soil divisions and the great soil groups of the United States.

In the first part of Chapter I the author classifies the soils as members of one of two systems: (1) the genetic, in which the relationship of the factors producing the soil are employed as criteria, and (2) the attributive, in which the soils' own attributes or features serve as a basis. The genetic factors are geology, climate, botany, and topography. The attributes of the soil are chemical composition, color, texture, and maturity. The last part of the chapter deals with the great soil groups—(1) the Pedalferic groups which include the Podsols, the Gray-Brownerths, the Red-and-Yellowerths, the Ferruginous Laterites, and the Prairyerths; (2) the Pedocalic groups which include the Blackerths, the Chestnuterths, the Brownerths and the Greyerths, and (3) the Rough Broken Land.

The Pedalfers are described in Chapter II and the Pedocals in Chapter III. In each chapter the author shows first the influence upon the soil of the environment—climate, natural vegetation, parent material, and land forms; and second, how the chemical and physical properties change the soil. The Prairyerths are considered apart from their allied groups in Chapter II, because they present such a striking contrast with the typical Pedalfers.

In the last chapter he points out how the two major soil divisions differ. The relatively infertile Pedalfers form the leading agricultural group, with the greater crop diversity. Forests dominate the natural vegetation of this group but with settlement, silviculture is governed more by economic than environmental conditions. The Pedocals while comparatively rich and of high fertility, are doomed by their relatively deficient rainfall principally to pastoral use, agricultural adjustments being confined to their moister peripheries.

Mr. Wolfanger has succeeded in putting before his readers the major soil divisions with their fundamental characteristics and in showing the essential and more geographic relationships of each division, a service which geographers have long awaited; but his disposition to introduce new terms that are unusual and must be defined, justifies a word of warning against multiplicity of new terms and consequent involved terminology such as has retarded the progress of ecology rather than promoted its advance.

ROSE ZELLER.

Douglass, Harlan Paul. *The Suburban Trend.* xi and 340 pp.; 25 charts. The Century Company, New York, 1925.

As the title indicates, this book is devoted to a study of the suburb in relation to the city. It follows a study made by the same author in his volume on "The Little Town" (1919). The first volume interpreted the town as a sort of half-way house between country and city, but the present volume has been compelled to conclude that the suburbs, in the main, are intermediate in form rather than in significance. In essence they are parts of the evolving cities and in sharp contrast

with the original rural pattern of social experience.

In the opening chapter of the book the author has taken several cities and has described and analyzed them showing (1) that its magnitude is generally proportionate to the congestion of the city center, and (2) that its relation to the city tends to vary directly as its distance from that center. In the following three chapters, he indicates the present extent of cities and their growth, how they vary and why.

Beginning with Chapter V, the author discusses the economic factor or the cost of suburban living. He states two main reasons why more people do not live in the suburbs: first, because they do not wish to live away from the city, and, second, because they cannot afford to. He goes further by indicating how these costs are met by those who do commute.

To give a concrete example of the development of a suburb, the writer has selected Webster Groves, Missouri, a residential suburb of St. Louis, with a population of about 10,000, almost exclusively American born. In this study he considers any special or distinctive characters of the suburban family; the occupation of the commuters and their prestige in the community; the handicap in natural leadership because it has no independent rural area to serve; the divided loyalties of the professional group; the deficiency in social institutions such as libraries, parks and playgrounds, a community center or any substitute for one like a Young Men's or a Young Women's Christian Association; and other public improvements which are pert to a live progressive community. Many of the things which he finds lacking in a suburban community can be found in a rural community which has grown more slowly so that these institutions have been able to keep up with the growth of the town.

A few things, however, can be said in favor of the suburban centers. Athletic clubs have often taken the place of the Christian Associations; schools are developed after the system of the city, but a larger proportion of the tax bill goes to education than in the parent city; the land is cheaper than in the crowded city districts; methods of living are somewhat improved over many city districts; and there are greater opportunities for the family to enjoy nature and recreation.

A rural element in suburban life is an important factor in many homes. Many families can keep a few chickens, a cow, and work a small area of land in which they raise many of their own vegetables, thus saving considerable in the household expenses. Several cases have been studied which show that the influence of the city decreases with increasing distance from the city. More land is devoted to trucking near the city, farms are smaller, dairying less important, but rents are higher.

In conclusion, the writer expresses the opinion that in the future most of the area of the nation will be covered with villages and farm lands such as one now finds in the more thickly populated portions of Europe and that most of these villages will be clustered about minor centers which, together with them, constitute the suburbs of cities of moderate size. Here much of the work, as well as the recreational interests, of the people will lie. With this increase of suburbanization there must be an increased knowledge and understanding of city planning which will care for the increase of population. In a great measure the hope of the future city lies in its suburbs.

HARRY K. HUTTER.

Huntington, C. C. and Carlson, Fred A. *Environmental Basis of Social Geography.* xxix and 486 pp., maps, charts, illustrations, bibliography, and index. Prentice-Hall, Inc., New York, 1929. 9 x 6 inches. $4.00.

Environmental Basis of Social Geography is an intriguing title but none the less a misnomer. It might better be "Social Geography" only, though even that title would be warranted merely in part. Certainly the book endeavors to include not only the "basis" but much of the "superstructure" of Geography as well. The "Environmental Basis" is inadequately and ineffectively, even superficially, treated, if, as the title suggests, this were the theme of the book; the "Social Geography" is likewise unsatisfactorily treated, though a goodly part of the text appears to be devoted to that elusive (perhaps illusive, or delusive, would be better) subject if economic geography, and to a lesser degree, political geography, and goodness knows what else (see page 15 of the book) be considered "social."

As an elementary introduction to the field, prepared expressly, as the preface states, for "college and university students beginning the old subject of geography," the book would better not have included, certainly not as the first chapter at any rate, the indefinite and apparently indefinable "nature and classification of geography." So much that is doubtful, or controversial, is set down as gospel in the first chapter that it is hard even for one who agrees in the main with the burden of argument and definition in the chapter to submit without protest against such dogmatic finality. To impose it upon the innocent undergraduate, unprepared to evaluate the arguments or follow their direction, seems unjust and unjustified. Perhaps at the end of the book he might be unwilling to accept the dogma laid down in the first chapter!

The book covers a wide, wide field! To cover this wide field within five hundred pages, it must be well organized and extraordinarily compacted; it must discriminate well between essentials and non-essentials, and discard all of the latter and some of the former; it must outline rather than elucidate—and these things it does remarkably well. It includes a wealth of suggestive material —the faculties of the collegiate departments who will be called upon to consider it for their classes must decide for themselves whether or not it is

suitable, and whether or no it is conveniently and wisely presented.

The book is bound well. The type is easy to read. Some of the illustrations are so blurred as to be valueless. The style in places is clear and pleasing, in others labored and heavy. The bibliography is rather well selected, and valuable. A mixture of good, bad, and indifferent, spread wide and in places thin—that is *Environmental Basis of Social Geography.*

W. ELMER EKBLAW.

Andrews, Roy Chapman. *Ends of the Earth.* 355 pp.; ills. Printed for the National Travel Club by G. P. Putnam's Sons, New York, 1929.

Between the youthful Roy Chapman Andrews shooting birds in the Wisconsin woods and the famous naturalist and explorer digging out dinosaur eggs in the Gobi Desert lie thousands and ten thousands of adventurous miles. *Ends of the Earth* is his remarkable story of the span of years that those miles filled; years that he spent traveling the world over to collect specimens of mammals, birds, and fossils for the American Museum of Natural History.

When Mr. Andrews first came to New York in 1906 just after graduating from Beloit College, he accepted the lowly work of scrubbing the floors of the American Museum in order to be ready for subsequent loftier tasks. Opportunity came in the form of building a seventy-six-foot model papier-maché whale and in bringing in the bones of an "honest-to-goodness" whale from a Long Island beach. The success of both of these efforts caused the Director to ask him to describe the whale for the Museum.

The scarcity of references showed him how little was known of whales, and he determined to find out more about them. With just his expenses paid he set out for Vancouver Island and the Alaskan coast. From his observations there and across the Pacific he gives a lively account of whales and whaling ending with the discovery of the supposedly extinct California grey whale on the coast of Japan.

Most of the remaining two-thirds of the book Mr. Andrews devotes to his explorations and life in the Orient. Collecting as he went, he has traveled from the jungles of the East Indies to the desert interior of China. Queer things happened to him everywhere; he fortunately escaped a writhing python in Borneo and poisoned traps in Malaya, only later to have a peaceful meal with Chinese bandits.

Convinced of the possibility of gaining valuable records of past ages in the interior of Asia, Mr. Andrews returned to this country to organize an expedition. He presented his beliefs and plans so enthusiastically and forcibly that he at once received the backing of the American Museum and some New York financiers. The work of the Gobi Desert Expedition with the exception of a casual mention of the finding of the dinosaur eggs is omitted due to the fact that another book of his tells that story. Instead of the expected trip into the heart of Asia Mr. Andrews tells of the social life in the foreign circle in old Peking. He writes with interest of polo ponies and Chinese cooking, yet he laughs at the tragic political situation and makes fun of the old religion. His apparent lack of sympathy for the Chinese people is regrettable.

The final chapter is an evaluation of the American Museum of Natural History and its scientist. Mr. Andrews pays special tribute to Dr. Carl Akeley of African fame, to Dr. Frank Chapman, the Curator of Birds, to Dr. George L. Sherman, the Director of the Museum, and to Dr. Henry Fairfield Osborne, its President. In concluding, he expresses his endless belief in the work of the Museum in placing natural history within access of the public.

To those who, like Mr. Andrews, feel "the lure of new lands," *Ends of the Earth* offers vicarious exploration and great enjoyment. Although somewhat sensational and fragmentary, it is a good narrative of a style and content which demand that it be taken lightly.

REBECCA M. TALIAFERRO.

Wills, L. J. *The Physiographical Evolution of Britain.* viii and 376 pp.; 2 plates; 154 sketches, maps, and diagrams. Edward Arnold & Company, London, 1929.

Dr. Wills has contributed to geological student literature a textbook in a new field, the physiographic evolution of former land surfaces. The contributions of paleogeographers, *i.e.*, "the distribution of land and sea, the general climatic conditions and the type of life at the different periods," form the background of the picture. In the foreground the author has tried "to place the physiographic processes that were at work in those surroundings, moulding and modifying the surface of the earth from period to period in those far-off days."

The book is divided into three parts, of which the first deals with Basic Principles, the second with the relatively simple Post-Carboniferous Systems, and the third with the much more complex Pre-Cambrian and Paleozoic Systems. The second and third parts follow the stratigraphic order except that volcanics are considered by themselves in a final chapter.

The organization of Part I is sufficiently unusual to justify its inclusion here.

Part I
  Principles of Physiography
    Subterranean Processes of Change
      Diastrophism, Vulcanicity, Metamorphism
    Surface Processes of Change
      Denudation
        Generalizations, Humid Climates, Dry Climates, Glacial Climates, Marine Erosion, The Geographical Cycle Under Humid Conditions

Deposition
Continental Deposits
Mechanically Formed, Organically Formed, Chemically Formed
Marine Deposits
Generalizations, Neritic Zone, Bathyal Zone, Abyssal Zone
Principles of Stratigraphy or Historical Geology
The Nature of the Geological Record

This part of the book is largely an enumeration and is intentionally incomplete, for throughout Parts II and III the characteristics of environmental forms are introduced or accompanied by a consideration of their physiographic causes. For instance, "The tendency for the floor of a geosyncline to buckle in places during the cycle of sedimentation that fills it up, is recorded by . . . unconformities with the Ordovician" . . . "the direction of these unconformities . . . in the Lake District seems to have been N.N.E." and further ". . . vulcanism usually accompanies the movements connected with a geosyncline. This is strikingly illustrated in the Ordovician."

Thus it appears that the author felt the need of Part I to set the stage, but tried to save his thunder for Parts II and III. The varying intensity, combination, and sequence of the physiographic processes in the past have left a record that is here presented as a series of landscapes, each explained by "the *study of processes* (author's italics) that is our primary object in this book."

The book is necessarily technical, but the author is very careful to cite examples and has provided a generous number of illustrations in black and white. The maps and diagrams are uniformly excellent, though some would be improved by the addition of a scale. No photographs are included. The author has chosen to sketch from borrowed pictures in a manner not always as effective as the other illustrations, pages 25, 110, and 111.

The trick of comparing former landscapes to analogous present vistas helps to visualize conditions. For instance, "The Aralo-Caspian Basin, together with North Persia and Turkestan, offers many features for comparison with the late Carboniferous and Permian geography of North-West Europe"; and again, "Probably the South China Sea with its varying depths and currents, muddy river mouths and coral-girt islands offers, as far as conditions governing deposition are concerned, the best present-day analogue to the Jurassic and Lower Cretaceous seas of Western Europe; the deeper-water deposits of the Upper Cretaceous were possibly formed under conditions . . . nowhere . . . paralleled at . . . present. . . ."

The book is attractively bound and printed and presents a difficult subject quite interestingly. It is of more interest to the British than to others because of the strictly local application of many of the principles, though the evolution of Europe is concurrenlty outlined. The rather detailed subdivision of the geological column and the English naming of the epochs further reduce the value as a reference to those American geographers who are not also stratigraphers. However, no geographer can read the volume without a new conception of the vicissitudes of the physiographic ancestry of Britain and of Europe.

MEREDITH F. BURRILL.

Newbigin, Marion I. *A New Regional Geography of the World*. xix and 432 pp., 57 sketch maps and diagrams, 29 illustrations, index, and questions. Harcourt, Brace & Company, New York, 1929.

"Is it possible, within reasonable limits, to take a world survey which shall combine a broad outlook with sufficient study of detail in regard to the more important areas to add interest and check hasty generalization? This is the problem which this book attempts to solve. . . ."

The book is divided into seven parts, one to each of the continents, and a final section entitled "Some Notes on Geographical Inter-relations." In Part I, consisting of 144 pages, Europe and its margins are considered. A general survey of Europe is given in the first chapter, and in the remaining seven chapters, sections of Europe are comprehensively treated as to structure and relief, natural vegetation, climate, resources, and human relations. In the treatment of all the European countries except Russia, structure and relief are almost overemphasized. That this was the intention of the author, however, is apparent, for in the introduction the statement is made that "great emphasis has been laid on these subjects, because in this way the key is given to the interpretation of . . . maps" and "the foundations laid on which more detailed knowledge can be built as the need or occasion arises." The chapter treating Russia and the new states, and that on Mediterranean Europe and its margins, though relatively brief and concise, contain much important information. The physical structure, plant cover, stages in growth, and new states of Russia are considered. In the Mediterranean region, the range of climate, crops and products, trade and exports are treated, followed by a discussion of the structure and relief of the various countries.

Four chapters, totaling 65 pages, are devoted to the continent of Asia. The position, structure and relief, natural regions, climates and political units are included in the general survey. Two chapters are given to the Monsoon Lands, one the Indian Empire and Ceylon, the other China, Japan, Indo-China, and the Malay Archipelago. The remaining chapter is a discussion of lands outside the monsoon belt. Asia is well treated, some political and historical material being included in relation to the geographic.

Part III, Africa, also contains four chapters

with a total of 47 pages. A general survey is first given, then the divisions of northern, equatorial, and southern Africa are discussed under topics similar to the above. Although the author states that "no rigid consistency of treatment throughout has been attempted" the topics included under each section are, of necessity, similar.

North America, Part IV, is treated in a manner somewhat different from that of the other sections. A general summary is first given, then Canada and Newfoundland are discussed as to area and divisions, distribution of population, resources and their distribution, and lines of communication. The treatment of the United States includes more of the historical than the discussions of the other sections, and Chapter 20 is a series of regional studies of the United States. The concluding chapter of the section takes up Mexico, Central America, and the West Indian Islands.

Two chapters are devoted to South America, the first a general survey and the second a discussion by states. Thirty pages are given to South America, while 32 pages are given to a discussion of the structure and relief, drainage and artesian water, climate, plants and animals, people, pastoral and agricultural produce, minerals, and lines of communication of Australia, New Zealand, and the Australasian Islands.

Part VII, the final section of seven pages on geographical inter-relations, discusses sites of towns and localization of industries. These are given as examples, showing how to work out a problem in order to explain a geographic fact.

The graphs and tables are comprehensive; the illustrations are numerous and well chosen; the relief and structure and vegetation maps are easily understood; however, some slight changes in the maps showing cultural features might make them more easy to understand.

The index of seven pages seems very complete. The last seven pages of the book are devoted to questions, divided according to the continents which they concern. These questions are diversified and thought-provoking. Some are simple questions, others call for answers which are comparative, descriptive, or expository.

The aim of the author to present a study of the structure, relief, vegetation, climate, resources, transportation, trade, and people of the regions of the world in a concise and interesting way has been accomplished. The book is excellent for reference or for use as a text in an elementary course of college geography.

VINA E. SPENCE.

ANNOUNCEMENT

THE series on the *Agricultural Regions of Australia*, by Dr. Griffith Taylor, begins in this issue and Dr. O. E. Baker contributes another instalment of his *Agricultural Regions of North America*.

Agricultural Regions of Africa, by Homer L. Shantz of the University of Illinois and president-elect of the University of Arizona; and *of Asia*, by Samuel Van Valkenburg of the College of the City of Detroit will follow in later issues to complete the finest geographic discussion of the world's agriculture thus far published.

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The January issue of Volume 6 contains the following articles:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potato Industry in Nebraska, Esther S. Anderson, University of Nebraska.
Agriculture in the Dry Region of the U.S.S.R., N. M. Tulaikov, Agricultural Experiment Station, Saratov.
The German Sugar Beet Industry, E. Muriel Poggi, University of Illinois.
Divisions of the Pine Forest Belt of East Texas, William T. Chambers, Stephen F. Austin State Teachers College.

The October issue of Volume 5 contains the following articles:

Geography's Part in the Plant Cost of Iron and Steel Production at Pittsburgh, Chicago, and Birmingham, Langdon White, Randolph-Macon Woman's College.
Readjustments in Post-War Cotton Culture, Earl C. Case, University of Cincinnati.
Tung Oil: Florida's Infant Industry, M. Ogden Phillips, Formerly, University of Florida.
The Farm Problem, Robert Stewart, University of Nevada.
Forest Regeneration in Porto Rico, William D. Durland, Formerly, University of Porto Rico.
The Topographic Map of the United States, Guy Elliott Mitchell, U. S. Geological Survey.
Agricultural Regions of South America, Clarence F. Jones, Clark University.

July includes:

Canada's Advance to Hudson Bay, Harold S. Patton, University of Cincinnati.
Economic Conditions in St. Vincent, B. W. I., G. Wright, Imperial College of Tropical Agriculture, Trinidad.
Economic Geography of the Hawaiian Islands, Otis W. Freeman, State Normal School, Cheney, Washington.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Iron and Steel Industry of the Cleveland District, John B. Appleton, University of Illinois.

April includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potash Industry of Europe, Fred S. Mohme, University of Illinois.
The Sugar Industry of the British West Indies and British Guiana with Special Reference to Trinidad, C. Y. Shephard, Imperial College of Tropical Agriculture.
Iron and Steel Industry of the Middlesbrough District, John W. Frey, University of Wisconsin.
The Grape Industry of Spain and Portugal, W. O. Blanchard, University of Illinois, and Elizabeth R. Blanchard.
The Philippine Lumber Industry, Luis J. Borja.

January includes:

Industrial China, H. F. James, Wharton School of Finance and Commerce.
Land Resource Inventory of Michigan, Carleton P. Barnes, Michigan Land Economic Survey.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Scranton's Industrial Integrity, Clifford M. Zierer, University of California at Los Angeles.
A Critical Situation in Two One-Crop Wheat Farming Districts in California, John W. Coulter, University of Hawaii.

The October issue of Volume 4 contains the following articles:

Fisheries of the South Atlantic and Gulf States, J. H. Matthews, Atlantic Coast Fisheries Company.
The Iron and Steel Industry of the Birmingham, Alabama, District, Langdon White, Randolph-Macon Woman's College.
America's Resources in Nitrogen, Potash and Phosphorus, Guy E. Mitchell, U. S. Geological Survey.
Possibilities of Rubber Production in Caribbean America, Jewell Venter, University of Missouri.
The Kentucky Geographical Surveys: A Review, W. Elmer Ekblaw, Clark University.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.

Single copies of back numbers of Volumes 1 and 2, 1925 and 1926, will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volume 3, 1927, Volume 4, 1928, and Volume 5, 1929, will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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